Power Cost Equalization Funding Formula Review

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Technical Report

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Executive Summary

The purpose of this study is to examine the current Power Cost Equalization (PCE) program formula's impacts on incentives for implementation of energy efficiency and renewable energy measures. In addition, it examines if alternative formula structures might improve market signals that are more conducive to investment in energy efficiency and renewable energy in rural Alaska. As part of the analysis we also present information on the history of the PCE program and levels and patterns of electricity consumption across regions of Alaska.

Alaska has large regional and intra-regional differences in energy consumption and prices that result from a number of factors including proximity to different types and quantities of resources, community population, remoteness, and transportation costs. Most communities in rural Alaska depend on volatile and high priced fossil fuels for the generation of electricity, space heating and transportation.

The Alaska statewide weighted average residential rate for electricity (17.6 cents per kWh in CY2011) is substantially higher than the U.S. average of 11.8 cents per kWh (U.S. EIA, 2012). Yet in Alaska the average residential rate per kWh is currently lower than in Hawaii (34.5 cents), New York (18.4 cents) and Connecticut (18.1 cents). Hidden in the Alaska statewide average is considerable variation with some communities paying less than the national average and some—generally those least able to afford it—paying among the highest in the country.

The Railbelt and Southeast regions have the lowest average residential electric rates (Appendix I map). North Slope residential customers also have lower average rates because of access to natural gas and North Slope Borough energy payments in addition to PCE disbursements. Most other regions have rates two to three times as high as Alaska urban rates. Some communities with hydroelectric power have notably low rates but customers are not paying the full, true cost of power because the cost of construction was heavily subsidized by state and federal governments. In Table 3 (p. 20) we present average annual residential electricity consumption and rates for different regions of Alaska.

Power Cost Equalization Program

The Power Cost Equalization program is a rural lifeline program with a funding formula tied to utility costs and rates thereby reducing electricity rates that residential customers and community facilities pay. The PCE program had two predecessors between FY1981 and FY1985, the Power Production Cost Assistance program and the Power Cost Assistance program; the current PCE was created in 1984. The PCE program has had only a few modifications over its almost 26 year life. Table 1 describes the differences across the programs, which in their basic structure and funding formulas are quite similar. In 2010, there were 190 communities that were eligible and participated in the PCE program.

The responsibilities of administering the PCE program are divided between the Regulatory Commission of Alaska (RCA)[1] that evaluates utility eligibility and costs per kilowatt-hour (PCE level), and the Alaska

[1] Originally APUC, Alaska Public Utilities Commission.

Energy Authority (AEA)[2] that determines the number of eligible kilowatt-hours (kWh) in order to calculate the appropriate payment and make the disbursement.

A utility's PCE payment per kWh is determined by a formula that covers 95% of a utility's cost between a floor or base rate of currently 13.42 cents/kWh and a ceiling of currently $1,00/kWh. The base rate is equal to the average price per kWh in Anchorage, Fairbanks and Juneau and is adjusted annually. PCE disbursements per customer are limited to a 500 kWh per month for residential customers and 70kWh per month and resident for community facilities. The PCE rate is re-calculated for eligible utilities once a year by RCA. The PCE formula also includes efficiency and line loss standards. State and Federal government customers as well as commercial customers are not eligible for the PCE credit.

Seven years after the PCE program was established, funding the program became a challenge as world oil prices sharply decreased, which lowered state revenues. Since inception, the program was not fully funded by the Legislature in 15 out of 25 fiscal years. However, per capita electricity consumption continued to steadily rise in the years of pro-rated funding.

During 2009 summer months, less than 18% of eligible communities had average electricity consumption levels above the PCE cap. Most of the communities where average monthly consumption exceeded the 500 kWh cap were communities that have effective rates comparable to those in urban areas (e.g., North Slope Borough communities)[3], have comparatively high incomes, and/or are located in southeast or southwest Alaska. Even during winter, about 60% of the PCE communities did not have average consumption above 500 kWh per month per customer. On average consumers that increase their levels of consumption by more than 10% during the winter months are those in communities where the effective rates[4] are below 30 cents per kWh.

The average PCE utility generates less than 3,000 MWh per year; about 30% of the utilities generate less than 500 MWh and the smallest generate less than 30,000 kWh per year. By comparison, urban utilities (Anchorage and Fairbanks) generate over 1 million MWh per year. This means urban utilities produce over 300 times more power than the average PCE utility. This difference illustrates one of the challenges in providing electricity (and other public services) to rural residents. The lack of economies of scale leads to very costly electricity per unit produced. The fixed costs associated with operating an electric utility are large and if the number of customers and/or levels of consumption are small these costs must be spread over few customers and kilowatt-hours.

Despite this challenge, the PCE program is fairly effective at bringing the first 500 kWh of residential electricity rates closer to Alaska urban rates. Communities with higher rates receive more relief, while regions with lower rates such as the North Slope receive lower levels of assistance.

[2] Originally APA, Alaska Power Authority

[3] The North Slope Borough communities benefit from availability of natural gas in some of its communities and additional subsidies. Rate structure is a flat rate of about 15 cents per kWh for all communities in the borough.

[4] Effective rate is the rate that the residential customer actually pays for the first 500 kWh consumed, (Residential Rate – PCE credit).

Analysis

There are four primary ways that the PCE program ultimately affects the price of electricity to rural residents, which in turn impacts efficiency, innovation and conservation incentives. One is a broad effect on prices and consumption. The second is the specific application of the current PCE formula as written in statute and applied by RCA. The third is how the application of the PCE formula affects s heat sales in high penetration (providing over 50% of power) renewable energy systems. The fourth is how the savings from integrating lower cost renewable resources is distributed among PCE eligible kWh, non-eligible kWh, and the PCE program.

PCE lowers the price of electricity for eligible kilowatt-hours; hence it allows customers/households to purchase more electricity and utilities to supply more power than they would if they were paying the full market price. However, comparatively high electricity rates coupled with low cash incomes result in average per customer electricity consumption of less than 400 kWh – over 40% less than the urban Alaska average of 700 kWh. It appears that the primary effect of the PCE program is increasing the quality of life of rural residents rather than encouraging "excessive" use of electricity. Because effective PCE rates remain relatively high, the larger barrier to household investments in demand side energy efficiency is likely insufficient household income and capital to finance the upfront costs of these investments.

For utilities, pressure from customers paying non-PCE rates (more than 50% of kWh, on average) probably overwhelms any effect of PCE to reduce the incentive to maximize generation efficiency in terms of kWh generated per gallon of diesel fuel. There are also generation efficiency and line loss standards that must be met in order to receive the full potential PCE level.

While the high cost of electricity may override any incentives caused by the PCE funding formula, the PCE program does not address the fundamental barriers to improving energy efficiency. Because the formula currently used to calculate rates is directly tied to fuel costs, integrating alternative or renewable generation technologies could result in a lower PCE payment causing the effective electric rates to increase. Knowing how the PCE level will change requires an individual analysis for each utility and generation alternative because alternative sources of generation affect non-fuel costs (which are also considered in the PCE formula), hence the PCE level may increase, decrease or remain the same. The new PCE level depends on how the utility cost structure changes and by how much.

A decline in fuel costs from the integration of renewable energy generation affects the PCE level calculations because in the formula the total fuel costs are divided by total kilowatt-hours sold, not just the kilowatts-hours sold that were generated using diesel fuel (see formula in text box below). At the time the current PCE formula was developed, all kWh were generated using diesel. Nowadays with over 30 renewable energy projects in rural Alaska, the current PCE formula incorrectly calculates the fuel cost component of the rate for hybrid generation systems. The larger the renewable generation, the lower the fuel cost per kWh that is used in the PCE formula to calculate the PCE level.[5]

[5] This complexity and scenarios of how integrating renewable affects the PCE level and effective rates is illustrated in the full report in the section "Fuel cost calculation effects", pg. 32.

PCE level = [(Non Fuel Costs/kWh Sold + Fuel Costs/*kWh Sold*) – Base Rate]*95%

Given that space heating is often the largest household energy expense in rural Alaska, sizing renewable energy capacity to increase economies of scale and produce excess electricity for space heating to displace fuel oil usage may make economic sense in some applications. It is especially important for rural wind-diesel installations aiming to generate more than 50% of their current energy consumption with wind, because wind is not a firm source of power and at times power production exceeds the available load. In those circumstances, using and storing the "excess" wind as thermal energy via electric boilers, ceramic thermal stoves, or other electric heating devices avoids having to curtail or waste renewable energy production already paid for in the hardware. The pricing of electric heat sales adds another layer of complexity to the application of the current PCE formula. From the perspective of the utility, the heat kWh needs to be priced to cover the cost of production but to be competitive in the market it must be priced less than the price of diesel fuel it displaces. Including heat kWh in the PCE formula further exacerbates the problem of dividing by all kWh sold rather than those kWh generated with diesel. A more appropriate application of the formula—dividing solely by diesel-generated electric kWh sold, and offsetting electric revenue requirements with heat sales revenues—can more accurately compensate the utility while providing benefits to community members.

Our modeling clearly showed that depending on wind-diesel system configuration and rate structure, the benefits resulting from high penetration wind-diesel systems can be distributed non-proportionally within the community. The benefits from harnessing excess energy are received primarily by commercial customers and the school/community if electric boilers are installed. Residential customers, on the other hand, face increased energy costs mainly due to decreases in PCE payments, as a result of the current funding formula. Given enough capital investment in residential electric stoves, residents could realize additional energy cost reductions, however, the decline in PCE payments would outweigh these other reductions.

If integrating renewable energy sources results in comparable or lower costs, this results in a clear benefit to the utility and community as a whole. Nonetheless, if these customers do not realize monthly savings on their bills, a "public relations" problem is likely to result for the utility. Customers typically focus on their monthly bills, not the price per kWh, not their total monthly consumption, not the PCE funding formula, and the amount of diesel consumed to produce their electricity.

If the PCE level declines causing the effective residential rates to increase for PCE eligible kWh, PCE eligible rate payers consuming below the 500 kWh cap see little benefit on their monthly bills because the savings accrue to the PCE program, not the rate payer. Alternatively, if the PCE level remains the same, these same customers still see no change in their monthly bills. If the PCE level increases, the effective rate marginally declines, thus providing some decrease to customer bills. But the latter only occurs if the renewable generation is more expensive than diesel fuel generation, which is counter to the purpose of integrating renewables and should not happen.

Preliminary estimates of rate effects of the renewable energy grant funded projects on effective PCE rates showed the proportion of savings to PCE eligible ratepayers was about 1-2% with the remainder of savings split between PCE ineligible ratepayers and the PCE program.[6]

Alternative PCE funding formulas

One of the objectives of this research is to analyze whether there are alternate funding formula structures to calculate PCE payments that would eliminate or reduce the energy efficiency and renewable energy disincentives created by the current PCE funding formula. [7]

When analyzing alternative funding formulas and comparing them to the current PCE funding formula, we used the following key parameters to evaluate whether the alternatives are improvements over the current system:

- ✓ Improves market signals
- ✓ Does not penalize increased energy efficiency or integration of renewable energy
- ✓ Has an equitable distribution across households
- ✓ Does not decrease the current distribution of funds to a community or utility
- ✓ Simplifies administration for utilities and state agencies and enhances understanding by customers/rate payers
- ✓ Simplifies formula and information needs for implementation

The current PCE program uses a rate/cost formula to calculate PCE reimbursement rates. The key variables in the current PCE formula for calculating rates are non-fuel costs and fuel prices and consumption. Under a formula rate program, the calculated rate is then applied to the eligible amount of kilowatt-hours to determine the PCE payment.

In contrast, a Fixed Payment formula provides a payment per given time period independent of rates and consumption. The fixed payment, however, can vary by community and be determined based on the differences in prices customers pay or the cost of producing electricity.

The examined formulas included a: cost index, rate index, combined cost and consumption index, geographic price differential index, life line fixed payment, and postage stamp rates. We found that the cost and index formulas had the potential to slightly improve market signals but did not provide much improvement over the current PCE funding formula based on review parameters.

Among alternate PCE structures we analyzed for this report, one deserves particular attention. We developed a fixed payment formula based on the per gallon price of fuel in a community, a generation efficiency rate, and the mean seasonal household monthly kWh consumption level. A fixed payment is calculated by dividing the price per gallon of fuel oil in a particular community (regardless of whether they generate their power with fuel oil or other sources; fuel price is used as a proxy to measure how

[6] Alaska Energy Authority, calculations for the Renewable Energy Fund Grant program review, January 2012.

[7] In order to analyze the programmatic effect of potential changes in funding formula structures from the current structure, the eligible kilowatt-hours cap was held constant at 500 kWh per residential customer per month.

much more costly it is to generate in one village compared to others) by a fixed generation efficiency of 14 kWh per gallon. This factor is then multiplied by the seasonal median monthly residential consumption.

[(Fuel price $/gallon) ÷ (kWh/gal)] *Average monthly consumption per season

The resulting fixed payment would be applied to the rate payer's bill every month and paid to the utility. However, to accommodate changes in seasonal consumption needs, the fixed payment would change by season so that during the summer months (April-September) the customer receives a lower fixed payment credit reflecting lower seasonal consumption levels, and in the winter months (October-March) the fixed payment would be higher reflecting higher winter consumption.

Applying this formula results in similar total residential disbursements as the current PCE funding formula. However, because the payment does not depend on the amount of fuel consumed and the customer receives payment regardless of consumption or rates, household and generation energy efficiency and renewable energy incentives are reestablished. If the utility is able to produce energy at lower cost through gains in demand or supply side efficiency or using renewable energy, the benefits to the utility and customer increases. Other criteria identified above, such as ease of program administration, are also met under this proposed formula.

An important feature of this potential Seasonal Fixed Payment formula as conceived for this research effort is that if the customer has an electric bill lower than the fixed payment, the balance could be carried over to future months as a credit. At the end of the year if the customer has a net credit, there are a number of options that the program could offer to customers. For example, the customer could use the credit to purchase more energy efficient appliances and/or lighting products, transfer the credit to a relative in the village who may need it, or simply carry it forward to the following year.

Other Policy Considerations

The PCE program is critical to many rural residents; restructuring the program to improve its effectiveness and efficiency is complex. There are no simple solutions to addressing the problems of high costs that rural utilities and residents face. In seeking solutions to these issues, it is important to approach the PCE program in the context of total energy use in rural Alaska. The PCE program alone has not and will not solve the fundamental issues that result in high cost energy and the impacts this has on rural residents.

Most PCE communities depend on fuel oil for both electricity generation and space heating. Consequently, high fuel oil prices increase both the cost of electricity and space heating, thus magnifying the pressure on households. Space heating is a larger share of overall energy costs, about 40% of household energy expenses, followed by transportation, about 33% (Colt, 2011), with the remainder devoted to electricity. PCE provides important relief on electricity rates; however, only about 27% of fuel consumed in PCE communities is used to produce electricity. On top of this, only about 30% of kWh used in eligible communities is affected by PCE effective rates—so the PCE program only touches about 10% of the energy picture in rural Alaska.

From a whole village perspective, one of the first objectives is to assist rural residents to be as energy efficient as possible to reduce the impacts of energy price volatility while maintaining quality of life. In addition to the current on-going weatherization efforts in rural communities, energy efficiency and conservation could be maximized to fulfill this objective. This does not mean that new efficiency and conservation programs are needed but instead existing programs can be better coordinated and delivered. For example, a recent weatherization and electrical retrofit on 13 community buildings and four teacher housing units in Nightmute was done as a concurrent effort. This more comprehensive and integrated effort resulted in estimated annual electric power savings of 59% and thermal energy savings of 56% (Butler 2010).

Power Cost Equalization eligibility depends on having a centralized utility. As a result, for some of the smallest communities there could be an incentive to over capitalize electricity generation despite the potential availability of less capital intensive and possibly more cost effective solutions. Further research is necessary to determine the population size at which a rural village may be able to access lower cost electricity through disaggregated self- generation rather than opting to run a centralized utility.

Finally, there has been recent discussion of expanding the PCE in its current form to include commercial customers and expanding the eligibility of residential customers. We analyzed how these expansions would impact the current PCE program.

Under the current PCE program structure, funding for disbursements would have to increase about $11 million or 35%, to provide assistance to commercial customers at the 500 kWh per month level. If eligibility was available for 700 kWh per month, funding would have to increase about $15 million or 47%. Average commercial customers' consumption in 93% of PCE communities would exceed the maximum eligibility cap of 500 kWh per month. At the 700 kWh per month cap, the average commercial customer's consumption would exceed the 700 kWh per month eligibility cap in about 77% of PCE communities. At the 500 kWh level in about 38% of communities, most commercial customers would see relief on half or more of their total electric consumption. In 60% of communities, most commercial customers would see relief on half or more of their total electric consumption at the 700 kWh level.

Increasing the eligibility threshold is not likely to provide substantial additional assistance to rural households. Limited levels of consumption among PCE communities suggest that given the current levels of PCE assistance, relatively low household incomes have a larger impact on their ability to consume more electricity than the PCE eligibility ceiling. Customers who would benefit the most from an increased eligibility cap are residential customers with lower effective rates who are already consuming significantly higher amounts of electricity each month, residential customers with higher incomes that consume more electricity than the average customer, or a small portion of customers that due to moderate effective rate and income levels are able to increase their electricity consumption due to seasonal changes during the winter.

Consequently, it is an inaccurate assumption that increasing the eligibility cap would translate into extensive economic relief for all PCE eligible customers, or those who may need the relief the most.

We estimated the increase in total disbursements to residential customers in CY2009 if the eligibility cap were 700 kWh per month. Raising the cap would have increased disbursements to almost $34 million from $31 million, or less than 8%. However, increasing the kWh ceiling would also increase the potential state liability by 40% to about $63 million, if all residential customers consumed up to the higher cap.

Introduction

Rural Alaska communities are remote, subject to challenging environmental conditions, and sparsely populated. These factors make it very difficult and expensive to provide basic services; energy is especially disadvantaged, and hence more costly, because of high heating degree days, poor housing stock, and soils that pose difficulties for construction of infrastructure. While rural Alaska is perhaps an extreme example, these issues are not unique to Alaska and there are no simple solutions to "…overcome the problems of high cost, remoteness and lack of economic base. Subsidies seem to be required to bridge the gap between high cost and affordable rates" (Colt et al., 2003, p.1). Most rural Alaska communities have mixed subsistence-cash economies with limited cash employment available to residents. Over the years, the Alaska State Legislature has established a number of programs to help rural residents cope with high energy costs, not only to provide economic relief to households but also with the intent to help support economic development in remote communities.

After the Prudhoe Bay oil field and Trans-Alaska pipeline began operation in 1977, state revenues grew dramatically. High state revenues as a result of high oil prices facilitated efforts to advance rural electrification. However, high fuel prices also significantly increased the cost of generating power in rural Alaska. Hence, the Legislature sought not only to expand rural electrification but also to make power more affordable. There has always been a tension between high oil prices that benefit the state treasury and the impacts of high prices on Alaska households. When oil prices are high, state coffers overflow, but these high prices simultaneously put strains on household budgets. As a result of higher costs and lower median incomes, high energy prices are especially hard on rural residents (Saylor, Haley, and Szymoniak 2008). When oil prices fall, state budgets are strained in their capacity to pay for any programs, including those directed at relieving rural household energy costs, which remain high as a result of high fixed costs. Rural energy costs are never low—they simply fluctuate between high and extremely high compared to urban Alaska and the rest of the country.

This paper focuses on the Power Cost Equalization (PCE) program that is intended to bring greater parity between electricity rates in rural Alaska and Alaska's urban centers of Anchorage, Fairbanks and Juneau. Currently, there is renewed interest in the PCE program as a result of increased fuel and electricity prices since 2008. As one response to historic high fossil fuel prices in 2008, the Alaska State Legislature created the Renewable Energy Fund program (REF), a grant program to encourage the development of renewable centralized energy generation. In 2010 the Legislature set energy policy goals of generating 50% of Alaska's electricity from renewable energy by 2025 and reducing per capita electricity use by 15% by 2020. This analysis investigates how the currently structured PCE program interacts with these recently adopted goals and, by extension the REF program.

The economic importance of the PCE program to rural utilities and customers is well established.[8] The program is clearly critical to the viability of rural communities and households and is in part a political

[8] The importance of the program has been addressed indirectly in a number of analyses of the PCE program and formula. "The Economic Significance of the Power Cost Equalization Program" by Dr. Scott Goldsmith (1998) is one of the most comprehensive studies on the importance of PCE.

result of past investment in urban energy infrastructure that required rural support and continues to provide benefits to the urban regions of the state in the form of large hydropower, high voltage transmission lines, and other subsidized infrastructure. **This paper takes the importance of the PCE program as given. The purpose of this paper is to examine whether potential changes to the funding formula improve program benefits to rural residents as well as help achieve the goals of increased energy efficiency and use of renewable energy.**

The first section covers the history of the PCE program, how the program operates and its impact on rural residents. This is followed by an analysis of the PCE program effects on incentives for efficiency and innovation. We then review alternative formula structures, how these alternatives affect the PCE program, and resulting policy implications. There have long been criticisms of the PCE funding formula structure because it is perceived to reduce incentives to utilities and rate payers for improving energy efficiency and for integrating renewable energy into their system. As part of this review, we investigate that perception.

When analyzing alternative funding formulas and comparing them to the current PCE structure, we used the following key parameters to evaluate whether they improved the current system:

- ✓ Improves market economic signals
- ✓ Does not penalize increased energy efficiency or integration of renewable energy
- ✓ Does not decrease the current distribution of funds to communities
- ✓ Has an equitable distribution across households
- ✓ Simplifies administration for utilities and state agencies and enhances understanding by customers/rate payers
- ✓ Simplifies formula and information needs for implementation

These parameters recognize the critical importance of PCE to communities and households while examining the principal issues that impact the current PCE funding formula structure.

Power Cost Equalization History

The first electricity assistance program established by the Alaska State Legislature was called the Power Production Cost Assistance (PPCA) program. It was implemented during state Fiscal Year (FY) 1981. Through this program, a portion of the generation and transmission costs of utilities with high rates were paid, which enabled utilities to reduce rates for residential, community facilities and charitable organization customers. About 15 utilities participated in this program benefiting 11,405 residential and commercial customers, 238 organizations and 473 community facilities (Alaska PowerAuthority, 1988). The PPCA program covered about 33% (40,490 megawatt-hours) of generated power. At that time the average per gallon cost of fuel for participating utilities was $1.054 (about $2.64 in 2010$$).[9] However,

[9] PCE program data is calculated on a state fiscal year basis. The fiscal year starts July 1 and ends June 30. Estimation of figures in constant dollars is done using the U.S. Department of Labor Bureau of Labor Statistics consumer price index (CPI) for a fiscal year.

the program lasted only one fiscal year during which it distributed $2.2 million in assistance (about $5.5 million 2010$$).

The legislature instituted significant modifications to the program in FY 1982 and renamed it the Power Cost Assistance program. This program operated from FY1982 to FY1984. The major changes included increases in the entry and ceiling rates, decrease in the portion of eligible costs for reimbursement and the inclusion of distribution and administration as eligible cost categories. The last year the program was implemented, it served 61 utilities benefiting 21,702 residential and commercial customers and 985 community facilities (Alaska PowerAuthority, 1988). The PCA program reduced the price of about 40% (96,520 megawatt-hours) of the generated power. At that time, the average per gallon cost of fuel for participating utilities was $1.70 (about $3.62 in 2010$$). The last fiscal year of operation the PCA program distributed $8.3 million in assistance (about $18.4 million in 2010$$).

The Power Cost Equalization program was created in 1984 when the Legislature enacted Alaska Statutes 44.83.162-165 replacing the Power Cost Assistance program. The program became effective in October 1984 (FY 1985) and was funded through appropriations from the general fund of $6.67 million (2010$$). Since that time, the PCE program has had only a few modifications over its almost 26 year life. Table 1 describes the differences across the programs, which in their basic structure and funding formulas are quite similar.

Over the years, the Alaska State Legislature has actively debated energy policy covering a wide span of issues from affordability and power availability in rural areas, to development of hydroelectric generating facilities, and goals of developing other renewable energy sources, as well as oil and gas policy. Many decisions regarding the PCE program were made in the political arena and were a result of trade-offs negotiated as part of the legislative process. In 1985, shortly after PCE was established, the origins of the program were described as follows in an Anchorage Daily News article:

> *"Power Cost Equalization is the result of a legislative trade by urban politicians who wanted Bush support for massive hydroelectric projects –the proposed Susitna and Bradley Lake Projects in the Railbelt and four other dams in Southeast Alaska. In return for tens of millions of dollars in state money invested in waterpower engineering and construction, the Bush delegation won equalization"* (Mauer, 1985)

To this day the PCE program continues to provide critical economic relief to rural communities throughout the state, but it does not address the roots of the problem of high costs and low cash incomes.

Table 1. Timing and characteristics of implemented power cost assistance programs

	PPCA (FY 1981)	PCA (FY 1982-1985)	PCE (FY 1985)	PCE (FY2000)	PCE (FY 2011)
Entry rate (2010 cents/kWh)	18.4	24.3	17.2	15.2	14.0
Ceiling rate (2010 cents/kWh)	96.0	91.2	106.4	66.5	100.0
Eligible costs for reimbursement	85%	95%	95%	95%	95%
Eligible costs for reimbursement over ceiling	Yes, 100%	No	No	No	No
Consumption Limits – Community Facilities[b] kWh/month	None	55 kWh per Resident	70 kWh per Resident	70 kWh per Resident	70 kWh per Resident
Residential & Commercial Consumption Limits kWh/month –	N/A	600	750[c]	500 Commercial no longer eligible	500 Commercial no longer eligible
Eligible cost categories for reimbursement	only generation and transmission	generation, transmission, distribution and administrative			

Source: Modified table "Comparison of PPCA, PCA, PCE and PCE-REC" (Brooks, 1995)
[b] Community facilities is defined as water and sewer facilities, charitable educational facilities, public lighting, or community buildings whose operations are not paid by the state, federal government or private commercial party.
[c] Starting in 1993, the PCE eligible kWh per month limit dropped to 700.

Program Implementation

The responsibilities of administering the PCE program were divided between the Regulatory Commission of Alaska (RCA),[10] which evaluates utility eligibility and costs per kilowatt-hour (PCE level), and the Alaska Energy Authority (AEA),[11] which determines the number of eligible kilowatt-hours in order to calculate the appropriate payment and make the disbursement. The legislature established criterion for utility eligibility that excluded urban areas and regions that benefited from hydroelectric development (Four Dam Pool utilities-- Kodiak, Port Lions, Valdez, Petersburg, Wrangell and Ketchikan) (Matz & Kreinheder, 1988, p. 11).

[10] Originally APUC, Alaska Public Utilities Commission.
[11] Originally APA, Alaska Power Authority

At its inception the program had the following key provisions:

- ✓ Utility provides electric service to the public for compensation
- ✓ During calendar year 1983, less than 7,500 megawatt-hours were sold to residential customers or less than 15,000 megawatt-hours if two communities were served and
- ✓ During calendar year 1984, diesel-fired generators were used to produce 75% of electricity

The program was designed and directed toward centralized utilities using diesel fuel to produce electricity. It was also designed to ease the ability of utilities to participate since according to statute "a utility may not be denied power cost equalization because complete cost information is not available" (State of Alaska, 1989, p. 16). The Legislature also required that participating utilities submit a monthly report that "records monthly kilowatt-hour sales or generation, monthly fuel balances, fuel purchases and monthly utility fuel consumption" (State of Alaska, 1989, p. 20). AEA would then review these monthly reports, check the calculations, determine the appropriate payment and make the disbursement.

Seven years after the PCE program was established, funding the program became a challenge as world oil prices sharply decreased lowering state revenues. Since inception, the program was not fully funded by the Legislature in 15 out of 25 fiscal years. In 1990, in an attempt to contain costs, the Legislature directed the Alaska Public Utilities Commission to implement new efficiency and line loss standards and to more clearly define eligible costs. To further address high operating costs, AEA provided technical support, preventative maintenance and upgrading/replacing equipment of rural utilities (Pourchot, 1990, p. 11).

In FY 1992, the program was pro-rated to 80% eligible PCE payments because of funding shortfalls for eleven months of the year. One year later, the Power Cost Equalization and Rural Electric Capitalization Fund (the PCE fund) was created by the Legislature with an appropriation of $101 million (2010$$). During subsequent years, PCE expenses were drawn exclusively from the PCE fund and were nearly spent by the end of FY 1999 (State of Alaska, Office of the Governor, 1999). This continued to be an issue until FY 2000 when the PCE program had full funding for one year.[12] Then, during FY 2001, the PCE Endowment fund was created. Originally the fund was capitalized using the proceeds from the sale of the Four Dam Pool Projects and funds from the Constitutional Budget Reserve. Later in 2007, the fund was once again capitalized with general funds. The Rural Electric Capitalization Fund and PCE program costs are appropriated using dividends from the PCE fund[13] (Alaska Energy Authority, 2009, p. 2). For the last three fiscal years, the PCE program again received full funding. Last year the legislature appropriated an additional $400 million for the PCE endowment fund. Figure 1 shows annual PCE appropriations, disbursements and average distillate fuel oil prices since the first program was implemented.[14]

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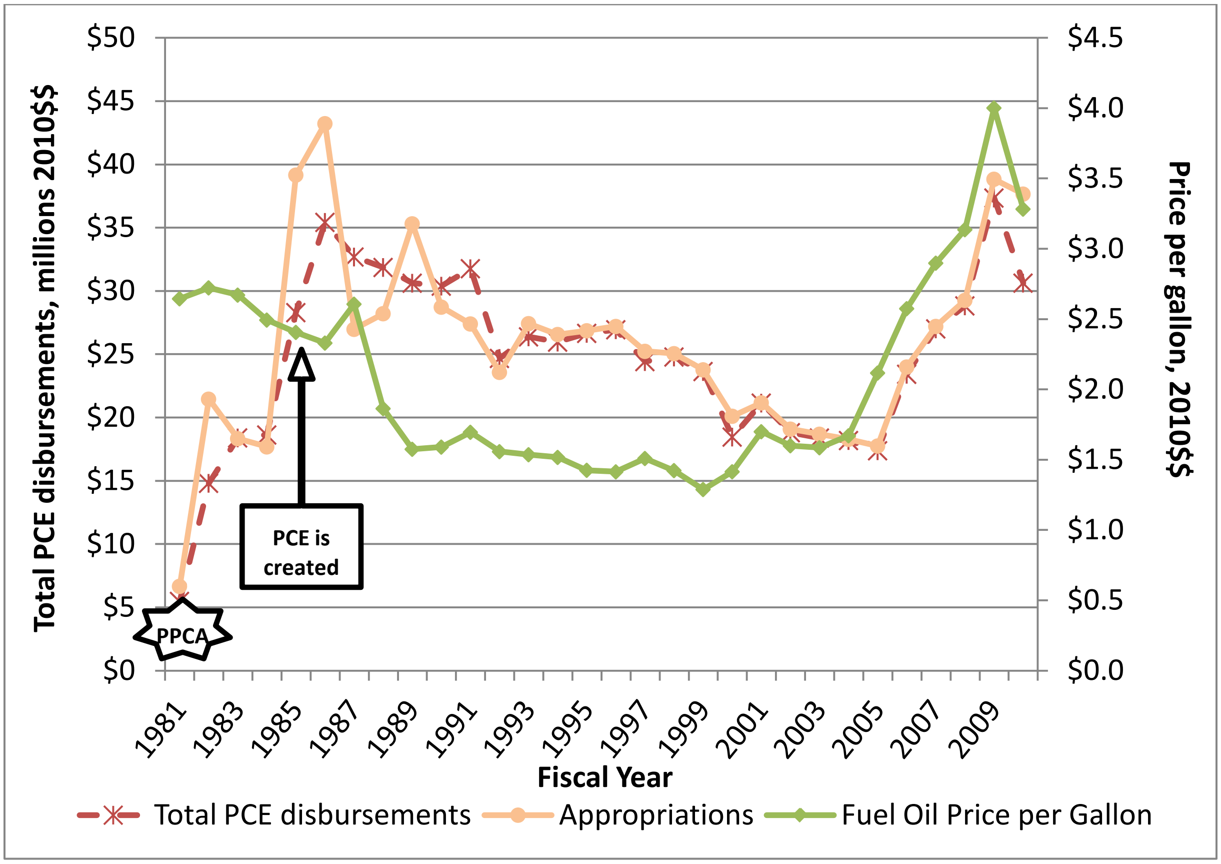
[12] Appendix A details PCE funding levels per year

[13] The fund is managed by the Department of Revenue; it is invested to earn 7% over time. Seven percent of the fund's 3-year monthly average returns may be appropriated.

[14] Historical data was gathered from PCE Annual Statistical Reports published by the Alaska Energy Authority since 1988, for further detail regarding data sources and methodology please see Appendix G.

Figure 1. PCE appropriations, disbursements and distillate fuel oil prices per gallon in the electric sector over time



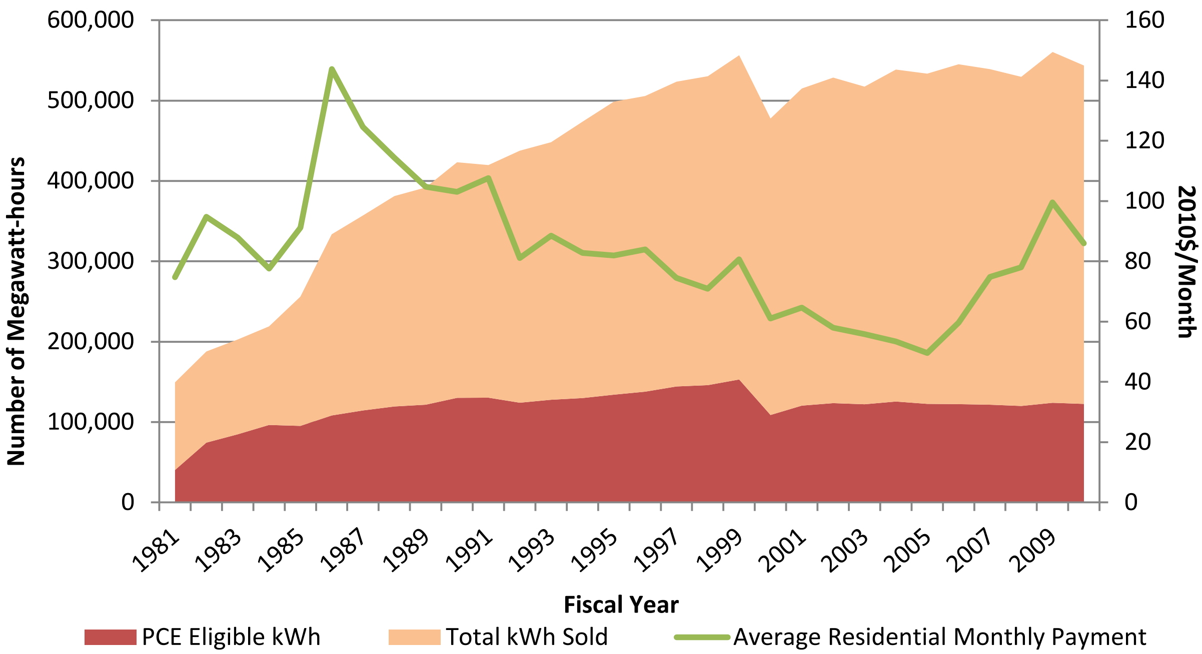
Source: PCE Statistical Reports 1988-2010 and Author's calculations.

Coping with volatile and generally increasing crude and fuel oil prices has been a challenge for the PCE program since its inception. Average fuel oil prices in the power sector in Alaska increased sharply between FY 1980 and FY 1981, and then decreased sharply until FY 1986. For participating utilities, average fuel oil prices were highly volatile but the average annual real price of fuel was relatively stable between FY 1981 and FY 1986. Because PCE was not fully funded in most years from FY 1992 through FY 2007, fuel prices and program payments were not highly correlated. Figure 1 shows how after the first year the PCE program was created, the total amount of funds disbursed steadily decreased while fuel oil prices had a volatile but relatively flat trend. However, after FY 2005 high fuel prices and program growth resulted in record high PCE disbursements. In FY 2009, coinciding with the 2008 crude oil price run up, PCE disbursements increased to about $37 million (2010$$).

Total electricity (kWh) sales of participating utilities steadily increased until FY 1999, the last year commercial customers where eligible to receive the PCE credit (Figure 2). Some of this increase resulted from additional utilities participating in the program. In FY 1999, in addition to eliminating reimbursements to commercial customers, the number of eligible kWh per month per residential customer was also decreased from 700 to 500 kWh. After that adjustment, consumption re-adjusted and continued an upward trend. However, the total number of kilowatt-hours eligible for reimbursement has remained relatively flat over time following adjustments in eligibility levels in FY 1993[15] and FY 2000. During the years of the PCE predecessor programs both sales and eligible kilowatt-hours exhibited higher growth, largely due to the increase in the number of participating utilities.

The average number of eligible kilowatt-hours grew at about 5% per year since FY 1985; the average annual population growth in participating utility communities was 2% over the same time period. Figure 2 shows kilowatt-hours sold, PCE eligible kWh and the average residential monthly payment per customer since disbursements became available to residential customers. The sharp declining trend during the 1990s and first half of 2000s resulted from pro-rated PCE disbursements due to lack of funding (Appendix A). Figure 3 shows kWh sold and PCE eligible kWh with average kWh sold per capita; notably per capita electricity consumption continued to steadily rise in the years of pro-rated funding. The sharp increase starting in FY 1985 coincides with the increase in eligible kWh from 600 (under the PCA program) to 750 after the PCE program was instituted and the increase in participating utilities. The sharp decrease in per capita consumption between FY 1987 and FY 1988 coincides with the crash of the Alaska economy due to a drastic decrease in world oil prices.[16]

Figure 2. Power sold, PCE eligible kWh and average residential monthly payment, 1981 to 2010



Source: PCE Annual Statistical Reports 1988-2010 and authors' calculations.

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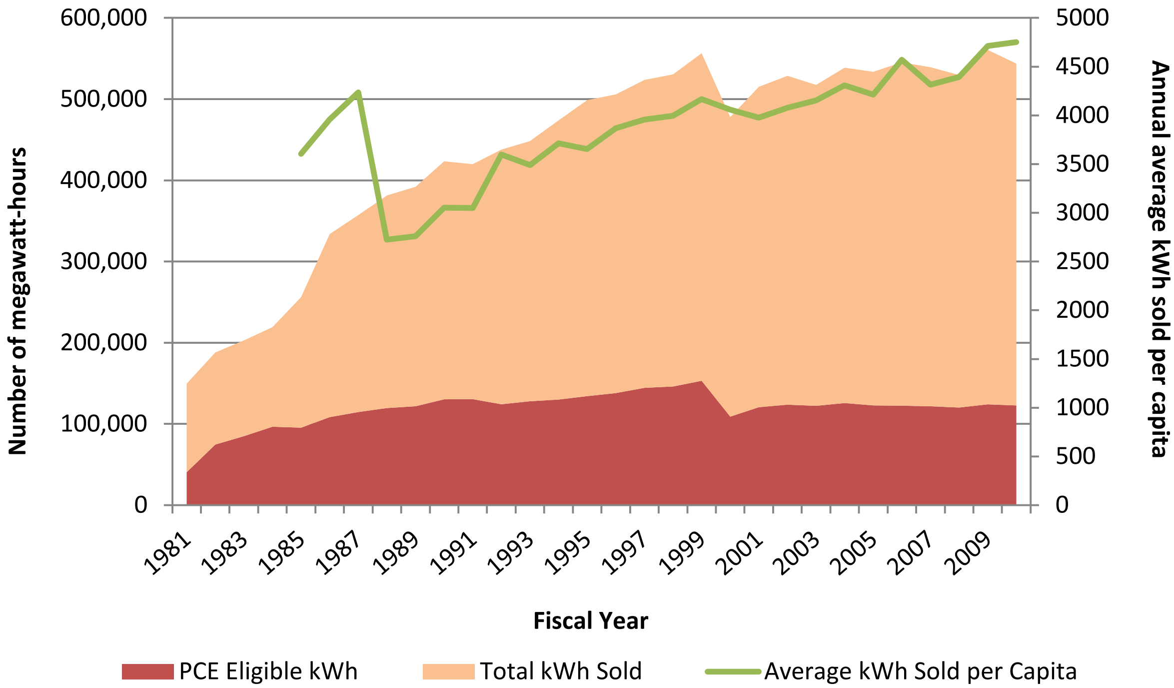
[15] In 1993, residential customer eligible kWh dropped from 750 to 700.

[16] Though oil prices decrease, the effects of the economic crash on lowering economic activity and income were likely the cause of the decrease in consumption. In general price elasticity of demand in PCE communities is highly inelastic. For more information about this topic please refer to Fay and Villalobos, All-Alaska Rate Analysis.

Figure 3. Power sold, PCE eligible kWh and average annual kWh sold per capita, 1981 to 2010



Source: PCE Annual Statistical Reports 1988-2010 and authors' calculations.

Table 2 shows eligibility and participation by utilities across regions of Alaska; in 2010, a total of 190 utilities were eligible and participated.

Table 2. Utilities/communities eligible and participating program, CY 2010

AEA Energy Region	Yes	Inactive	No	Total	Percent Active
Aleutians	12	1	0	13	92%
Bering Straits	17	0	0	17	100%
Bristol Bay	25	1	0	26	96%
Copper River/Chugach	6	0	2	8	75%
Kodiak	4	1	1	6	67%
Lower Yukon-Kuskokwim	48	0	0	48	100%
North Slope	7	1	0	8	88%
Northwest Arctic	12	1	0	13	92%
Railbelt	0	0	14	14	0%
Southeast	21	0	10	31	68%
Yukon-Koyukuk/Upper Tanana	38	3	2	43	88%
Total	**190**	**8**	**29**	**227**	**84%**

Note: For utilities that serve multiple communities with no grid such as AVEC and AP&T, each community is counted individually.
Source: Alaska Energy Statistics report 1960-2010, ISER (2011).

Electricity Rates and Levels of Consumption

The biggest challenge in providing electricity (and other public services) to rural residents lies in the lack of economies of scale; this intractable problem is difficult to overcome. The fixed costs associated with running a utility are large and if the number of customers and/or levels of consumption are very small these costs must be spread out over very few customers and kilowatt-hours. Most PCE communities are similar in that they produce all or most of their electricity using diesel generators, have small populations, and customers pay electricity rates higher than customers in Anchorage, Fairbanks and Juneau. However, across PCE communities there are significant differences in remoteness, population sizes (ranging from 8 to about 6,000 people), available means for transporting and storing fuel, income and other factors that ultimately affect their electricity prices.[17] Hence, there is a large variability in electricity rates across PCE communities, which in turn, affect their levels of electricity consumption (Table 3).

Table 3. Average Annual Residential Electricity Consumption and Rates, 2008-2010

	kWh per Customer			Before PCE			After PCE		
AEA Region	**2008**	**2009**	**2010**	**2008**	**2009**	**2010**	**2008**	**2009**	**2010**
Aleutians	4,776	4,788	5,014	0.48	0.40	0.44	0.22	0.21	0.21
Bering Straits	4,569	4,751	4,524	0.41	0.47	0.44	0.16	0.20	0.21
Bristol Bay	4,219	3,910	4,131	0.43	0.50	0.47	0.17	0.21	0.28
Copper River/Chugach	4,054	4,297	4,331	0.28	0.25	0.26	0.18	0.19	0.18
Kodiak	4,380	4,779	5,145	0.20	0.17	0.18	0.12	0.13	0.16
Lower Yukon-Kuskokwim	4,157	4,262	4,333	0.52	0.58	0.52	0.19	0.22	0.24
North Slope	5,918	7,480	8,230	0.14	0.14	0.13	0.11	0.13	0.12
Northwest Arctic	5,537	5,755	5,860	0.48	0.56	0.51	0.21	0.20	0.21
Railbelt	8,080	7,897	7,514	0.16	0.16	0.15	0.16	0.16	0.15
Southeast (Non PCE)	11,412	12,244	11,733	0.11	0.10	0.10	0.11	0.10	0.10
Southeast (PCE)	4,545	4,460	4,290	0.43	0.38	0.41	0.18	0.19	0.19
Yukon-Koyukuk/ Upper Tanana	3,191	3,348	3,322	0.53	0.52	0.52	0.20	0.22	0.23

Source: Alaska Energy Statistics 1960-2010, (2011).

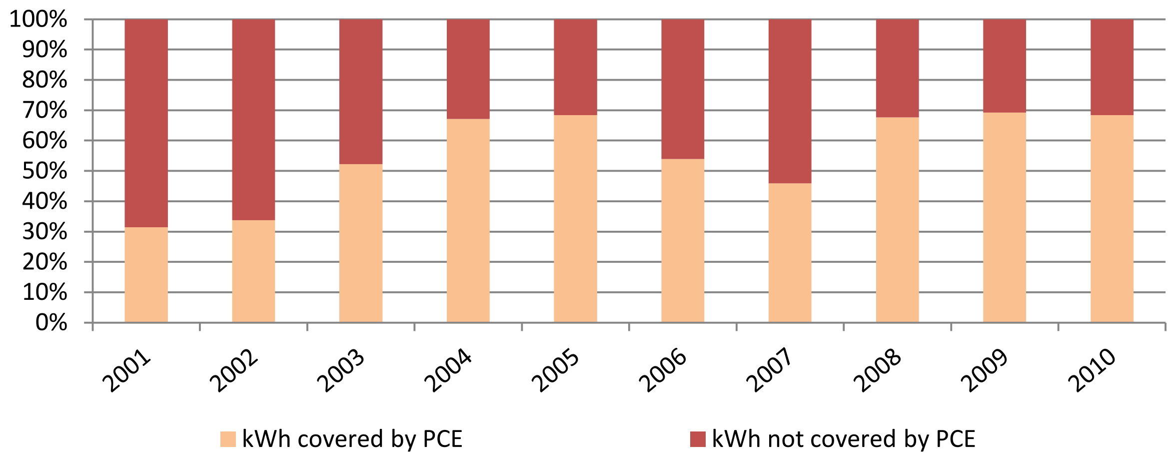
However, on average, PCE residential customers consume significantly less (over 40%) electricity per month than customers in urban areas of Alaska. Average annual per customer residential consumption in most Alaska regions is between 4,000 and 6,000 kWh per year or 333 and 500 kWh per month. The Yukon-Koyukuk/Upper Tanana region has the lowest at just over 3,000 kWh per year or 250 kWh per month. In the Railbelt average annual consumption in Fairbanks is 8,285 kWh and Anchorage is 7,475 kWh or 690 kWh and 623 kWh per month, respectively. The average PCE utility generates less than 3,000 MWh per year; about 30% of the utilities generate less than 500 MWh and the smallest generate

[17] Appendix F lists PCE communities and their residential and effective rates, average consumption per residential customer per month, population, average household size (2004), average real median income (2004) and average fuel prices in 2009.

less than 30,000 kWh per year. By comparison, urban utilities (Anchorage and Fairbanks) generate over 1 million MWh per year. This means urban utilities produce over 300 times as much power as the average PCE utility.

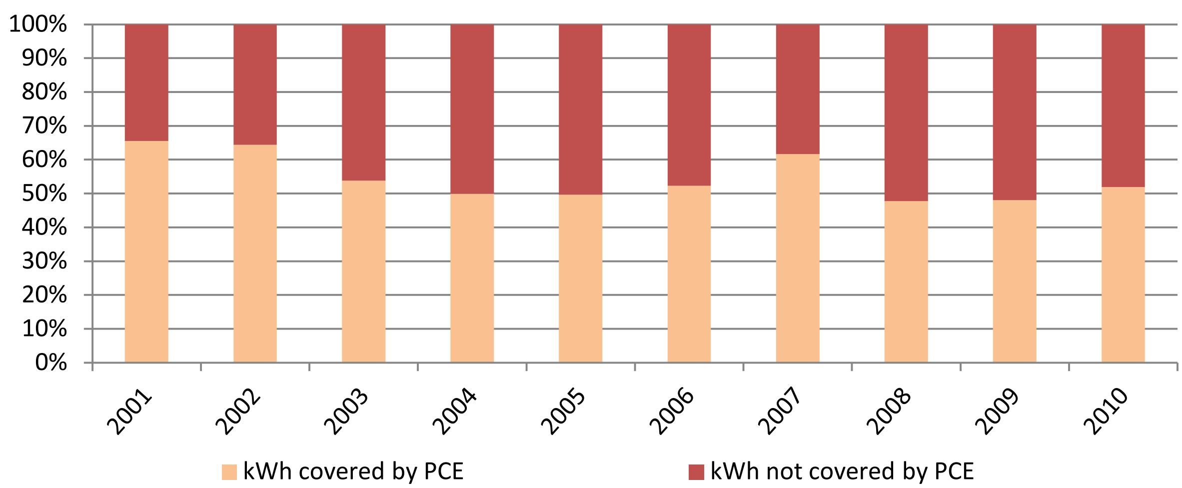
Overall, less than 30% of all kWh sold in PCE communities receive PCE credit. However, the importance of this assistance to residential customers and community facilities is significant. As illustrated in Figure 4, in CY2010, almost 70% of all residential kilowatt-hours received PCE credit. PCE also provides significant assistance to community facilities; Figure 5 shows that of all kilowatt-hours consumed by community facilities in CY2010, about 50% received PCE reimbursement.

Figure 4. Residential kWh sold in PCE communities



Source: PCE Annual Statistical Reports 1988-2010 and authors' calculations.

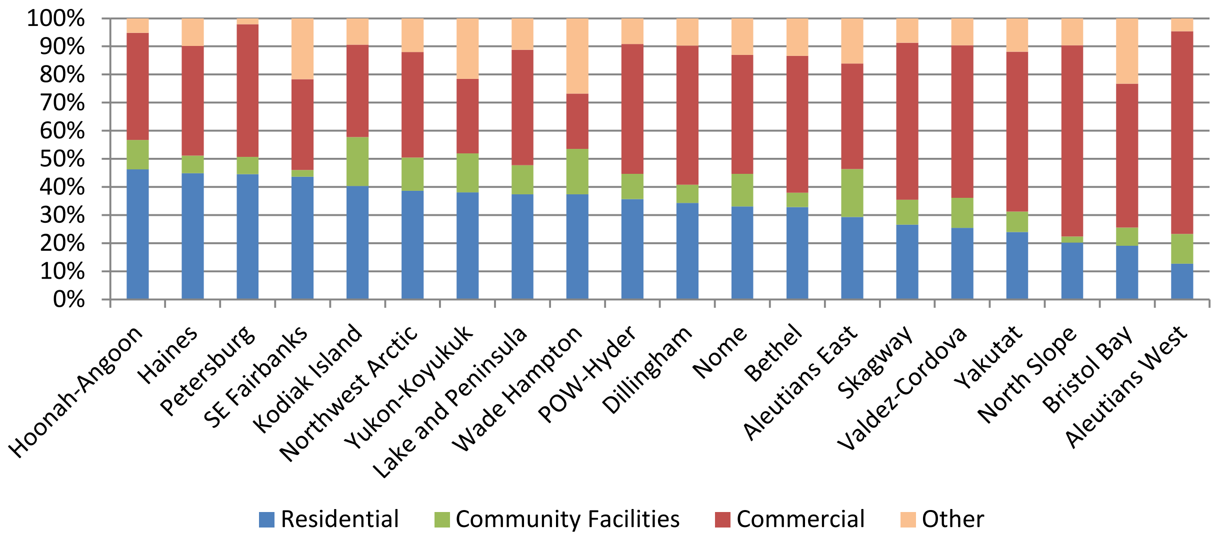
Figure 5. Community Facilities kWh sold in PCE communities



Source: PCE Annual Statistical Reports 1988-2010 and authors' calculations.

The effect of the PCE program varies across communities depending on the proportion residential and community facilities comprise of total utility kWh sales. Figure 6 shows kWh sales by customer category by census area. Regions are organized from the largest to smallest residential customer share to illustrate the regional differences in demand composition by customer categories. It illustrates how in the census areas of Hoonah-Angoon or Yukon-Koyukuk among others, residential and community facilities sales account for about 50% of total kilowatt-hours sold. In comparison, in census areas such as Bristol Bay or North Slope, residential and community facility sales are less than about 25% of total kilowatt-hours sold. Most of the regions on the right side of the chart with large portions of commercial customer power sales have large fish processing operations that have high electricity demands.

Figure 6. Kilowatt hours sold by customer category and census region, CY 2010



Source: PCE monthly program data CY 2010 and authors' calculations.

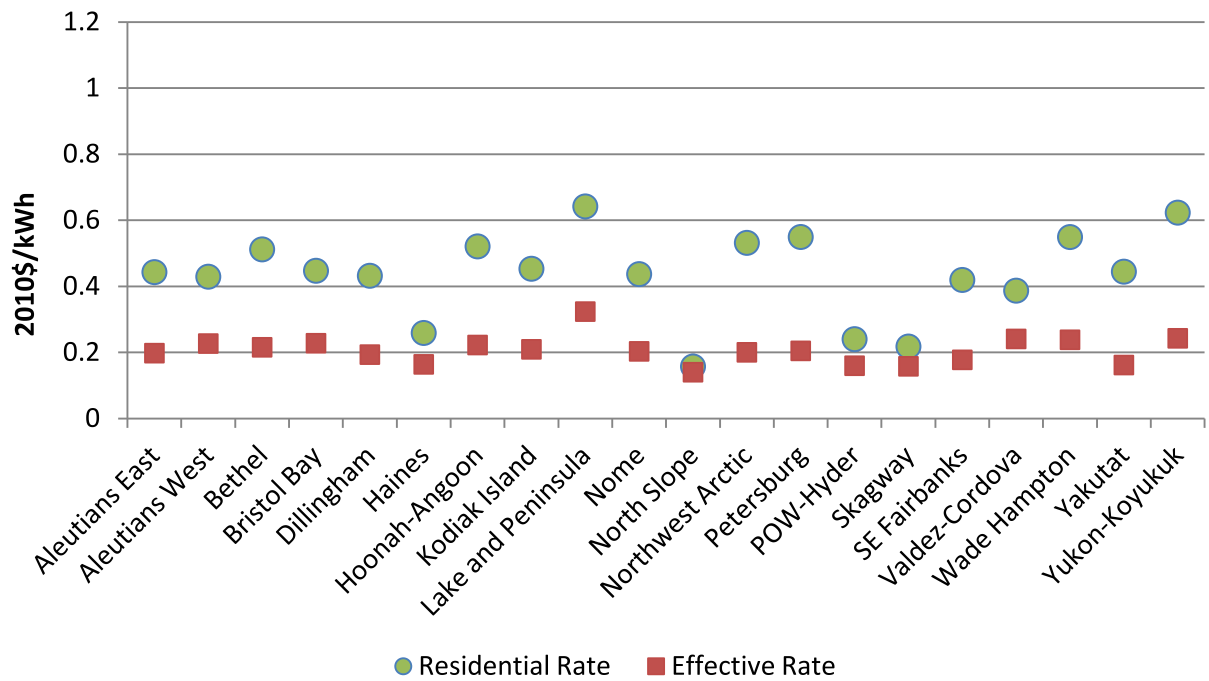
Similarly, Figure 7 shows the proportion of eligible customers by region starting with the region with the largest share of eligible customers from left to right. Regions that have large industrial sectors also have lower shares of PCE eligible customers.

Figure 7. PCE eligible and non-eligible customers by region, CY 2010

Source: PCE monthly program data CY 2010 and authors' calculations.

Figure 8 shows both the average residential and effective rates (residential minus PCE credit). It exemplifies how the PCE program is fairly effective at lowering the effective residential rates for the communities served. Those regions (and communities) with higher rates receive more relief, while regions with lower rates such as the North Slope, receive lower levels of assistance.[11]

Figure 8. Average residential and effective rates of PCE communities by census region, CY2010



Source: PCE monthly program data CY 2010 and authors' calculations. Averages are weighted.

In most PCE communities average consumption per customer per month is below the 500 kWh PCE eligibility cap. Table 3 shows the different levels of consumption at various rates. During summer months in 2009, less than 18% of eligible communities had average consumption levels above the PCE cap. Most of the communities where average monthly consumption exceeded the 500 kWh cap were communities that have effective rates comparable to those in urban areas (e.g. North Slope[18]), have comparatively high incomes, and/or are located in southeast or southwest Alaska. Even during winter, about 60% of the PCE communities did not have average consumption above 500 kWh per month per customer. On average, as shown in Figure 9, consumers that increase their levels of consumption by more than 10% during the winter months are those in communities where the effective rates[19] are below 30 cents per kWh.

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[18] The North Slope Borough communities benefit from availability of natural gas in some of its communities and additional subsidies. Rate structure is a flat rate of about 15 cents per kWh for all communities in the borough.
[19] Effective rate is the rate that the residential customer actually pays for the first 500 kWh consumed, (Residential Rate – PCE credit).

Table 3. Average consumption per customer per month in PCE communities, CY 2009

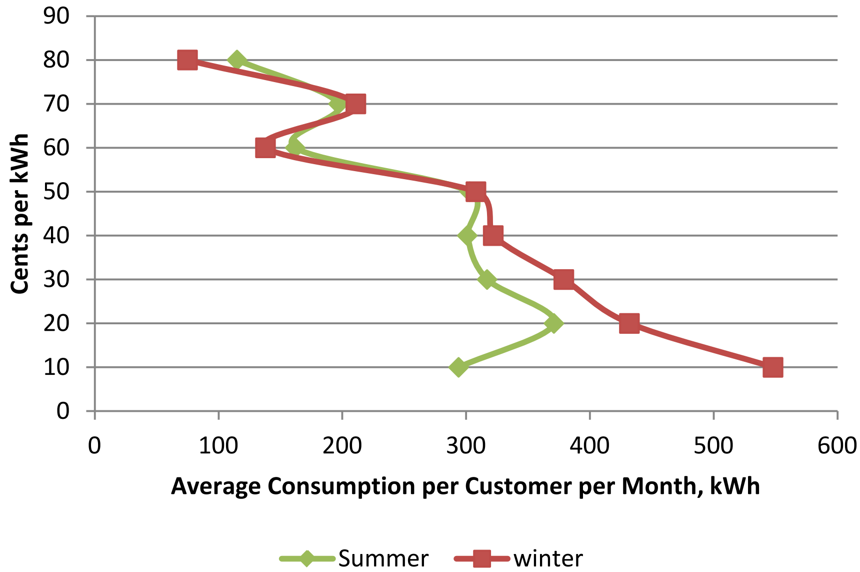
Calendar Year 2009 - Summer (April-September)					
Effective Rate	**Min**	**Mean**	**Max**	**No. Communities**	**No. Observations**
Less than $0.10	203	**294**	345	0	3
$0.10 - $0.19	107	**371**	924	57	527
$0.20 - $0.29	113	**317**	717	96	330
$0.30 - $0.39	140	**301**	486	9	84
$0.40 - $0.49	182	**303**	501	5	27
$0.50 - $0.59	69	**162**	329	2	21
$0.60 - $0.69	115	**197**	293	2	7
More than $0.70		**115**		0	1
Calendar Year 2009 - Winter (October - March)					
Effective Rate	**Min**	**Mean**	**Max**	**No. Communities**	**No. Observations**
Less than $0.10	324	**548**	816	1	6
$0.10 - $0.19	100	**432**	970	49	597
$0.20 - $0.29	92	**379**	966	101	276
$0.30 - $0.39	144	**322**	606	10	58
$0.40 - $0.49	148	**308**	506	7	37
$0.50 - $0.59	53	**138**	365	2	13
$0.60 - $0.69	81	**211**	351	2	8
More than $0.70	59	**75**	91	0	2

Source: PCE monthly program data CY 2010 and authors' calculations. Note that the number of communities in the summer only adds up to 171 and not 172; this is because not all PCE communities file their monthly report year-round. In this case a community only filed during some of the winter months. Also the number of communities within a rate range is determined by taking the monthly average for the season; hence in some cases it may show a number of observations, but zero communities.

Overall price elasticity of demand for electricity in PCE communities is highly inelastic (Villalobos Melendez, 2012) and communities with higher effective rates have significantly lower demand. In addition, generally the consumption range in communities with higher effective rates is measurable smaller than in communities with higher rates. Essentially, residential customers with effective electric rates above $0.30 per kWh are consuming such a small amount of electricity that it is difficult to consume much less during any time of the year.

Measuring how much more households are consuming because of PCE is a very difficult question to answer for two primary reasons: 1) The program has been in place for several decades and there are no residential customers in PCE communities who are not eligible for the PCE program to enable a comparison. 2) There are no household level data that enable estimation of the actual differences caused by the subsidy.

Figure 9. Seasonal changes of electricity consumption in PCE communities, CY 2009[20]



Source: PCE monthly program data CY 2010 and authors' calculations.

The most likely explanation for why consumption levels are significantly lower than the eligibility cap and so unresponsive to price changes over such a large price range is that the income effect on consumption overwhelms the price effect.[21] In other words, customers can not afford to consume any more electricity even at the PCE effective rates because their incomes are insufficient. These price and income effects also seem to have a compounding effect because communities with the highest electric rates also tend to be the smallest and most remote communities that have the lowest average incomes (see appendix F for information on median household incomes and electric rates).

How the current Power Cost Equalization funding formula works

The PCE program reduces the kWh electric rates charged to rural residents in areas where residential rates are high. The RCA determines utility eligibility and the PCE level (the amount paid per kWh). The PCE level is determined by a formula based on a utility's rates or costs, whichever is less.

[20] This figure is based on discrete data and the lines do not represent a functional relationship between consumption and price, but the lines help visualize seasonal differences. The formal functional relation between consumption and price for PCE communities is reviewed more extensively in All-Alaska Rate Analysis by Fay and Villalobos, 2012.

[21] A change in the demand of a good or service, induced by a change in the consumers' discretionary income. Any increase or decrease in price correspondingly decreases or increases consumers' discretionary income. The price of electricity reduces the amount of discretionary income available to purchase more electricity to the extent that there is no discretionary income available to purchase more electricity even if prices decline.

Lesser of

PCE Rate = [(Non Fuel Costs/kWh Sold + Fuel Costs/kWh Sold) – Base Rate]*95%
or

PCE Rate = [Residential Rate –Base Rate]*95%

if < maximum allowed rate

A utility's PCE payment per kWh is determined by a formula that covers 95% of a utility's cost between a floor or base rate (average rate for Anchorage, Fairbanks and Juneau, 13.42 cents/kWh) and a ceiling (currently $1.00/kWh) for a defined level of consumption (500 kWh for residential customers, and 70 kWh per month multiplied by the community's population for public facilities). The PCE base rate is re-calculated every year by RCA. Also, the PCE level is re-calculated for eligible utilities at least once a year based on the utility's annual filing or if the utility files for a re-calculation of the PCE level based on rates and/or fuel price changes. State and Federal government customers as well as commercial customers are not eligible for the PCE credit.

There are other factors that also affect the calculation of the PCE level including minimum efficiency standards for diesel generation depending on the quantity of electricity the utility produces. Table 4 shows how utilities that produce more than 80% of electricity from diesel have slightly higher efficiency standards than those who produce less than 80% of electricity from diesel. Also, utilities that produce more kilowatt-hours are expected to have higher levels of efficiency. In addition, a maximum 12% distribution line loss standard is expected from all utilities. If the minimum level of efficiency or the line loss exceeds the standards allowed, the PCE level is decreased. An important consideration related to these standards is that they have not been updated to keep up with technological changes since they were implemented in FY 1990. For these standards to be meaningful it is important that they reflect achievable goals of current technologies.

Table 4. Minimum efficiency standards for electricity generation

Total Generation (kWh)			Total Diesel Generation	
			More than 80%	Less than 80%
			kWh/gal	kWh/gal
0	to	99,999	9.5	8.5
100,000	to	499,999	10.5	10.0
500,000	to	999,999	11.5	11.0
1,000,000	to	9,999,999	12.5	12.0
	More than	10,000,000	13.5	13.0

Source: Table recreated from the PCE Program Guide, 2011, Alaska Energy Authority.

Participating utilities are required to file reports with both RCA and AEA; these reports are used to approve costs and determine the utility's PCE reimbursement rate per kWh. Unregulated utilities must file an annual report with RCA accompanied by accounting documentation such as balance sheets, invoices and other details to support their costs. RCA uses these records to verify allowable costs for power production. If RCA deems any of the costs ineligible, those costs are not included in the calculation of the PCE level. Regulated utilities can also request a Cost of Power Adjustment (COPA) to adjust their fuel costs between PCE level adjustments. Most utilities participating in the PCE program are unregulated (about 73%).

In addition to annual reports, all participating utilities must file a monthly report with AEA containing production and sales information including total kWh generated, gallons of fuel used, and kilowatt-hours sold. This report is used to determine the number of kilowatt-hours eligible for PCE level reimbursement. Utilities also submit copies of their customer ledger documents that AEA uses to verify that kilowatt-hours sold are eligible. Utilities self report to RCA and AEA; the agencies and their functions relative to the PCE program are independent. Utilities are instructed to submit consistent information to both agencies, but there is no on-going process to audit or reconcile the consistency of the information provided to both agencies.

Analysis

Information for this analysis was obtained primarily from existing reports and datasets. Details on data used and data documentation are contained in Appendix G. In addition, we performed a literature review of previous reports and analyses regarding changes to policy and program guidelines.[22] Finally, we conducted informal and semi-structured interviews with utility managers, program managers and other leaders in the industry.

Impacts of PCE on efficiency, innovation and conservation incentives

There are four primary ways that the PCE program ultimately affects the price of electricity to rural residents, and thus efficiency, innovation and conservation incentives. One is a broad effect on prices and consumption. The second is the specific application of the current PCE formula as written in statute and applied by RCA. The third is how PCE impacts heat sales in high penetration systems. The fourth is how the savings from integrating lower cost renewable resources is distributed among PCE eligible kWh, non-eligible kWh and the PCE program. We will discuss each of these four issues sequentially below.

General price and consumption effects

The PCE program in its current form has a range of impacts on economic incentives. Economic theory tells us that more of a good is consumed as prices decline. Because PCE lowers the price of electricity for eligible kilowatt-hours, it allows customers/households to purchase more electricity and utilities to supply more power than they would if they were paying the full market price. However, because the cost of producing electricity in most PCE eligible communities is so high, the residential customer rates (referred to as the “effective rates”) even with PCE are still very high. Comparatively high electricity rates coupled with low cash incomes result in average per customer electricity consumption of less than 400 kWh—over 40% less than the urban Alaska average of 700 kWh. While residents in PCE communities may be consuming more electricity than they would if they were paying market prices,

[22] A complete list of sources is listed in the “References” section.

their consumption is in the realm of "lifeline" levels barely powering what would be considered essential modern household functions such as lights and refrigeration. It appears that the primary effect of the PCE program is increasing the quality of life of rural residents rather than encouraging "excessive" use of electricity.

On the other hand, by lowering the price of electricity PCE lengthens the payback period of household investments for energy efficient products and lowers the energy efficiency incentives to households. However, this effect may be outweighed by the relatively high electricity prices households pay even with PCE effective rates. The larger barrier to household investments in demand side energy efficiency such as more efficient appliances and lighting is likely insufficient household income and capital to finance the upfront costs of these investments. An increase in residential energy efficiency does not necessarily result in utilities having to cope with lower electricity demand because these household efficiency gains may allow households to increase consumption over time, thus becoming more likely to reach parity with urban household consumption levels, and increasing rural quality of life.

At the utility level, there are generation efficiency and line loss standards that must be met in order to receive the full potential PCE level. If these generation efficiency standards are not met, the PCE level is lowered. In addition, utilities submit detailed documentation regarding their operating costs and RCA determines if costs are eligible. Yet, the reporting complexity and limited resources of some utilities may result in detailed operational data not being updated frequently, resulting in PCE levels being lower than necessary to cover actual utility costs.[23]

Utility generation standards provide a disincentive to generate at lower efficiencies. However, adjustments in the PCE effective rate calculations are complex and utility clerks and rate payers may not fully realize that they have forgone a portion of the PCE payment because the utility is generating power less efficiently than the standards. There are also a myriad of causes of poor efficiency including old generators, generators poorly sized for the load, failing transmission lines and transformers, deferred and insufficient maintenance, lack of operator training, and loads that are too small to support a central generating facility, all of which are difficult for small cash strapped utilities to control or address. The Alaska Energy Authority (AEA) and other institutional support have improved this situation generally, but the needs and issues are so diverse and complex that it is impossible to fully overcome.

Probably the most significant incentive utilities have to operate as efficiently as possible is the fact that for most utilities, PCE eligible kWh are less than half of the total kWh sold. So a significant number of their customers are paying the full rate for all (commercial and other) or a portion of their kWh consumption (residential and community facilities). In many cases, the cost to self-generate for their commercial customers may be similar to the rates these customers are paying the utility. So the utilities are under substantial pressure to keep their rates as low as possible because losing commercial customers is likely to send the utility into a downward spiral of escalating costs and declining sales over which to spread the costs, along with declining generation efficiency as the load decreases. From the

[23] Work with some rural utilities on their cost structures and limited review of PCE non-fuel cost data suggest that this issue is not uncommon.

utility perspective, this results in disincentives to have either individuals or commercial customers self generate, generate renewably, or decrease their load through efficiency or conservation.

In summary, while PCE reduces the rates paid for eligible kWh, for most residential customers the effective rates are still sufficiently high and household cash incomes sufficiently low such that most customers minimize electricity use. Low income and high energy costs coupled with volatile fossil fuel prices and the fiscal challenges of fully funding the PCE program, result in a high level of "energy insecurity" in most rural communities. The PCE data show that average per residential customer consumptions is well under the cap of 500 kWh. The fact that average consumption is lower than the allowable cap illustrates a degree of uncertainty by residential customers regarding if and how much reimbursement they will actually receive. For utilities, pressure from customers paying non-PCE rates probably overrides any effect that PCE may have on reducing the incentive to maximize generation efficiency in terms of kWh generated per gallon of diesel fuel. While the high cost of electricity may overwhelm the disincentives caused by the PCE funding formula, the PCE program does not address the fundamental barriers to improving energy efficiency and saving rate payers money in rural communities.

However, the PCE funding formula structure does result in a disincentive towards innovation and alternate sources of energy as potential solutions to the problem of high costs of rural energy because PCE is directly tied to fuel costs. As a result, integrating alternative or renewable generation technologies may result in a lower PCE payment causing the effective electric rates to increase. Knowing how the PCE level will change requires an individual analysis for each utility and generation alternative because alternative sources of generation affect non-fuel costs (which are also considered in the PCE formula), hence the PCE level may increase, decrease or remain the same. In other words, the new PCE level depends on how the utility cost structure changes and by how much. Considering the impact of PCE is highly situation specific and difficult to predict, perhaps the policy could be better targeted if it were aimed at answering the following question: what do we want to incentivize?

Fuel cost calculation effects

A decline in fuel costs affects the PCE level calculations because in the formula the total fuel costs are divided by <u>all kilowatt-hours sold</u>, not just the kilowatts-hours sold that were generated using diesel fuel (see text box below). Table 5 shows a generic example of how dividing fuel costs by total kWh sold results in a decrease in the fuel cost variable used in the PCE level formula. Hence the way fuel costs are calculated in the PCE formula becomes a financial disincentive against integrating renewable generation and also increasing the penetration of renewable power generation. This results because the larger the renewable generation, the lower the fuel cost per kWh that is used in the PCE formula to calculate the PCE level. The simplified examples below should help to clarify this complexity.

PCE Level = [(Non Fuel Costs/kWh Sold + Fuel Costs/*kWh Sold*) – Base Rate]*95%

if < maximum allowed rate

Table 5. Example of PCE fuel costs calculations and its effects on renewable generation

Generation from diesel, 100%		Generation from diesel, 50%	
Total fuel costs	$1,000	Total fuel costs	$500
Total kWh sold from diesel	10,000	Total kWh sold from diesel	5,000
Total kWh sold	10,000	Total kWh sold	10,000
Fuel costs/kWh sold from diesel	$0.10	Fuel costs/kWh sold from diesel	$0.10
Fuel costs/total kWh sold	$0.10	Fuel costs/total kWh sold	$0.05

In order to illustrate how the effect of reduced fuel cost could decrease the PCE level and lead to higher effective rates for residential customers, we developed two scenarios of renewable integration based on PCE program data. We review the differences in the rate calculations between generating all electricity with diesel with generating electricity with a hybrid diesel-renewables system. The first scenario reviews the changes for a utility with high renewable penetration using hydroelectric generation. The second scenario reviews the changes for a utility with low renewable penetration using wind generation. However, the type of renewable generation is immaterial to the results.

In both scenarios we assume that total generation, total kWh sold, average fuel price and residential rates remain constant. Though these factors may also change, we keep them constant to clearly illustrate the effect of fuel costs in the current PCE level formula. In the first scenario we assume that non-fuel costs remain the same (though this is unlikely in any renewable energy system); and in the second scenario we assume that non-fuel costs increase at about 3 cents per kilowatt-hour. Table 6 shows the calculations of the PCE level for both scenarios.

Scenario 1 shows a PCE utility moving from generating all electricity with diesel to having a high renewable penetration hybrid system of 90% hydroelectric and 10% diesel generation. This change leads to a decrease in fuel costs by 90%. Consequently, their total cost per kWh drops and so does the PCE level, by about 33%. The result is an increase in the residential effective rate from 16 cents/kWh to 28 cents/kWh (about 75%).

Scenario 2 shows a PCE utility moving from generating all electricity with diesel to having a low renewable penetration hybrid system of 9% wind and 91% diesel generation. This change leads to a decrease in fuel costs of about 9%. In this scenario, we assumed an increase in non-fuel costs of 3 cents per kWh sold and this leads to an increase of 17% in total non-fuel costs. After the decrease in fuel costs and the increase in non-fuel costs, the total cost per kWh increases 2 cents/kWh and the PCE level increases 1 cent/kWh. Consequently, although the residential effective rate ($0.18) decreases 1 cent/kWh (from $0.19 in the diesel only column), this decrease in the effective rate would have been larger if the fuel cost/kWh calculation in the PCE formula had only been done using kWh sold that were generated with diesel and not all kWh sold. This computational design is based on the formula being developed when it was assumed all generation would be done with diesel fuel. If fuel costs per kWh were calculated based only on the kWh sold generated with diesel, the fuel costs per kWh would have remained constant. Under this more accurate application of the formula, residential customers would have seen a 17% decrease in their effective rate.

Table 6. Sample PCE level calculation before and after integrating renewable energy

	Scenario 1				Scenario 2			
Generation	**Diesel Only**		**Diesel-Hydro**		**Diesel Only**		**Diesel-Wind**	
Renewables generation, kWh	0		1,507,416	(90%)	0		341,956	(9%)
Diesel generation, kWh	1,682,428	(100%)	175,012	(10%)	3,866,416	(100%)	3,524,460	(91%)
Total generation, kWh	1,682,428		1,682,428		3,866,416		3,866,416	
Total kWh Sold	1,454,633		1,454,633		3,646,178		3,646,178	
Costs								
Total fuel consumed	89,307		9,290		288,771		263,231	
Average fuel price	2.31		2.31		2.63		2.63	
Total fuel costs	206,045		21,434		758,991		691,864	
Fuel cost/kWh sold	0.14	(27%)	0.01	(4%)	0.21	(54%)	0.19	(51%)
Non-fuel costs	542,128		542,128		641,935		751,320	
Non-fuel cost/kWh sold	0.37	(73%)	0.37	(96%)	0.18	(46%)	0.21	(49%)
PCE Calculations								
Total costs/kWh	0.51		0.39		0.38		0.40	
Base rate	0.13		0.13		0.13		0.13	
PCE costs	0.38		0.26		0.25		0.26	
Eligible PCE costs	95%		95%		95%		95%	
PCE rate	0.36		0.24		0.24		0.25	
Rates								
Residential rate	0.52		0.52		0.43		0.43	
-PCE rate	0.36		0.24		0.24		0.25	
Effective rate	0.16		0.28		0.19		0.18	

This uncertainty regarding the impact on the resulting PCE level may be a disincentive toward seeking renewable sources of generation. If integrating renewable energy sources results in comparable or lower costs, this results in a clear benefit to the utility and community as a whole. Table 7 illustrates the effects the residential customer may see in their monthly bill under the two scenarios discussed above. If these customers do not realize monthly savings on their bills, a "public relations" problem is likely to result for the utility. Customers focus on their monthly bills—not the price per kWh, not their total monthly consumption, not the PCE funding formula, nor other factors except what they must pay each month. An expected rational reaction of utilities would be to further increase non-fuel costs beyond the actual added costs from renewable energy integration to help offset the inaccurately large calculated decrease in the fuel costs portion of the formula.

Table 7. Example of effects on customers' bills from integrating renewables

	Scenario 1		Scenario 2	
	Diesel Only		Diesel-Wind	
	No PCE	PCE	No PCE	PCE
Residential rate	$ 0.43	$ 0.19	$ 0.43	$ 0.18
Monthly Bill @ 400 kWh/month	$ 172	$ 76	$ 172	72
Monthly Bill @ 600 kwh/month	$ 258	$ 138	$ 258	133

Renewable energy and electric heat[24]

Given that space heating is the largest household energy expense in rural Alaska, sizing renewable energy capacity to increase economies of scale and produce excess electricity for space heating to displace fuel oil usage can potentially make economic sense. This is especially important for rural wind-diesel installations. Wind is not a firm source of power and at times production can exceed the available load depending on the wind energy system capacity. In those circumstances, using the "excess" wind for heat via electric boilers, ceramic thermal stoves, or other electric heating devices avoids having to curtail or "dump" production. This disincentive under PCE is then magnified when adding renewable energy capacity for heat.

Pricing of electric heat sales add another layer of complexity with the current PCE formula. The kilowatt-hours sold for heat should be priced to cover the cost of production yet less than the price of diesel fuel it displaces. Including heat kWh in the PCE formula further exacerbates the problem of dividing by all kWh sold rather than diesel generated kWh only. An alternate application of the formula, dividing solely by diesel electric kWh sold, and offsetting electric revenue requirements with heat sales revenues can more accurately compensate the utility while providing benefits to community members.

Even when using diesel only systems and filing for PCE under the current program structure, the complete accounting of non-fuel costs seems to be a challenge and there is some evidence that the calculations of non-fuel costs may not be updated frequently enough, resulting in partial forgone PCE level. In most cases adding renewable energy to an electric generation system will increase non fuel costs, hence accounting for those costs accurately and adjusting rates appropriately is very important when adding high penetration of renewables for electric heat sales.

We conducted additional analysis on how PCE levels are affected by high penetration wind diesel systems utilizing excess wind power for residential and community heating purposes. The analysis is based on ISER's IRECOS (Isolated Renewable Energy Economic Simulator)[25] and the following assumptions:

- 10% line loss
- 100% availability

[24] This section presents shared model analysis done by our colleague Tobias Schwörer to whom we are grateful for his contribution.

[25] IRECOS was developed to analyze high penetration renewable energy systems while accounting for stochastic variables like wind speed and availability of the energy system. More information in regards to this model can be obtained upon request.

- 100% collection rate
- All excess electricity is sold in form of heat to residents and the community at 8 cents/kWh
- Electric heat is metered separately from electricity
- Residential electric heat is provided in 30 of the 100 households of the case study community (limited heat sink dependent on number of stoves and seasonal demand for heat)
- Community electric heat is used to heat water for the washeteria/school (unlimited heat sink)
- The utility has one electric rate that is based on the remaining revenue requirement after heat sales are realized.
- Costs are modeled based on real fuel and non-fuel costs observed in the case study community and estimated wind turbine costs described below.
- Residential households consume 1,000 gallons of stove fuel per year and consume 500kWh/month on average
- Retail price for stove fuel: $5.55/gal
- Diesel price for utility: $4.55/gal

The heat rate roughly equals the incremental cost of wind power which we estimate to be $0.075/kWh, consisting of $0.029/kWh for operations and routine maintenance, and $0.045 for repair and replacement. For the case study community, this price is equal to half of the energy equivalent stove fuel price.

In order to investigate the sensitivity of PCE levels to the amount of renewable (non-firm) energy production, we show four scenarios (Table 8) with different levels of renewable energy production. Scenario 3 is diesel-only, while Scenario 4, 5, and 6 are wind-diesel with installed nameplate wind capacity of 100kW, 300kW, and 500kW, respectively. We assume that non-fuel costs in scenarios 4, 5, and 6 are what they are in scenario 3 plus the incremental cost of wind $0.08/kWh multiplied by the amount of renewable energy generated. Thus, non-fuel costs are increasing the more wind turbine capacity is added to the system.

We used IRECOS to run 1,000 iterations within two simulation runs. Based on the above assumptions, the wind-diesel system in our case study community would generate on average more than twice what it produced as a diesel-only utility, 2,000,000 kWh instead of 900,000 kWh. Since wind-diesel systems of this size are capable of reducing fuel costs substantially, the cost of power is estimated to drop by ten percent, outweighing the increase in non-fuel costs. Since PCE levels are calculated based on the average cost (cost of power divided by all firm and non-firm power generated), PCE levels would drop from 54 cents/kWh for the diesel-only utility, to 15 cents/kWh in scenario 6. The effective electricity rate for residential customers consuming less than 500kWh/month, under the current PCE formula would increase from 17 cents under the diesel-only to 39 cents/kWh in scenario 6. Assuming heat is sold at 8 cents/kWh, residential customers owning electric stoves would cut their heating bills by $500 annually. Considering the household budget for energy, the decrease in PCE would outweigh the reduction in heating costs. Under the current PCE formula, residents of communities harnessing wind for residential heating purposes would see an increase in their energy costs of up to 12 percent.

On the other hand, reduced fuel costs in scenario 4, 5, and 6 would benefit commercial customers who are ineligible to receive PCE, such as the commercial sectors or schools. In our case study community, commercial customers could realize a reduction of 23 percent in their cost of electricity.

Our modeling exercises clearly showed that dependent on wind-diesel system configuration and rate structure, the benefits resulting from high penetration wind-diesel systems can be distributed non-proportionally within the community. The benefits from harnessing excess energy mainly go to commercial customers and the school/community given they have electric boilers. Residential customers, on the other hand, face increased energy costs mainly due to decreases in PCE payments under the current formula. Given enough capital investment in residential electric stoves, residents could realize additional energy cost reductions, however, the reductions in PCE would outweigh the benefits.

Table 8. PCE and heat sales in high penetration systems

	Scenario 3		Scenario 4		Scenario 5		Scenario 6	
	Diesel-only		Wind-diesel		Wind-diesel		Wind-diesel	
Wind capacity, kW			**100**		**300**		**500**	
Generation								
Renewables generation, kWh	0	(0%)	278,363	(27%)	835,149	(56%)	1,391,980	(69%)
Diesel generation, kWh	899,840	(100%)	735,313	(73%)	655,997	(44%)	630,823	(31%)
Total generation, kWh	899,840		1,013,676		1,491,146		2,022,803	
Consumption								
Electricity sold,kWh	809,552	(100%)	809,552	(90%)	809,552	(61%)	809,552	(45%)
Heat sold, kWh	0	(0%)	92,340	(10%)	525,931	(39%)	1,005,857	(55%)
Total kWh sold	809,552		901,892		1,335,483		1,815,409	
Costs								
Fuel cost, $/kWh sold	0.47		0.28		0.17		0.12	
Non-fuel cost, $/kWh sold	0.23		0.21		0.14		0.10	
Wind for heat cost, $/kWh sold			0.08		0.08		0.08	
Rates								
Heat rate, $	*none*		0.08		0.08		0.08	
Avg. electric rate,$	0.70		0.56		0.54		0.54	
-final PCE level, $	0.54		0.36		0.22		0.15	
Effective rate, $	0.17		0.20		0.32		0.39	
Residential customer energy costs								
Electricity, $	998		1,191		1,944		2,360	
Heat, $	5,550		5,550		5,086		4,970	
Total	6,548		6,741	3%	7,030	7%	7,330	12%
Total community fuel displacement								
Generation, gal	*none*		29,298		34,501		36,115	
Residential space heating, gal	*none*		2,413		6,967		8,696	
Community water heating, gal	*none*		273		8,331		20,561	
Total fuel displacement, gal	0		31,984		49,799		65,372	

Sources: Institute of Social and Economic Research, Isolated Renewable Energy Economic Simulator model, IRECOS, February 2012; Alaska Energy Authority, PCE program data.

Distribution of renewable energy savings

If the PCE level declines causing the effective residential rates to increase for PCE eligible kWh, PCE eligible rate payers consuming below the 500 kWh cap see little benefit on their monthly bills because the savings accrue to the PCE program, not the rate payer. Alternatively, if the PCE level remains the same, these same customers still see no change in their monthly bills. If the PCE level increases, the effective rate marginally declines providing some decrease to customer bills. **But the latter only occurs if the renewable generation is more expensive than diesel fuel generation, which is counter to the purpose of integrating renewables and should not happen.**

Preliminary estimates of rate effects of the renewable energy grant funded projects on effective PCE rates showed the proportion of savings to PCE eligible ratepayers was about 1-2% with the remainder of savings split between PCE ineligible ratepayers and the PCE program.[26] This preliminary estimate (Table 9) is consistent with the estimates shown in example Scenario 1 (above in Table 6), and in Scenario 6 of renewable integration for heat sales (above in Table 8).

Tables 9 and 10 provide example summaries of the savings distributions from integrating renewable energy generation based on scenarios 1 and 6 above. These examples use FY 10 PCE data from utilities to calculate the specific saving distributions across different classes of rate payers and the PCE program. Table 10 Scenario 7 is based on scenario 6 in Table 8 above but applies a community's specific cost structure to calculation of potential distribution of savings from integrating renewable resources.

Table 9. Example of PCE savings distribution from integrating renewables

Scenario 1- Diesel-Hydroelectric		
For eligible customers (48% of all kWh sold)		**Savings distribution**
Production cost savings/kWh	$0.12	
PCE eligible kWh	692,489	
PCE program savings/kWh (based on 95%covered by PCE program)	$0.12	
Total PCE program savings	$81,798	45%
Customer savings (based on 5% not covered by PCE program)	$0.01	
Total eligible customer savings	$4,305	2%
For non-eligible customers, 100% savings (52% of all kWh sold)		
Non-eligible customers' savings/kWh	$0.12	
Total non-eligible kWh	$762,144	
Total non-eligible customer savings	$94,763	53%
Total production savings from renewable energy integration	$180,866	

Source: Alaska Energy Authority, PCE program data.

[26] Alaska Energy Authority, calculations for the Renewable Energy Fund Grant program review, January 2012.

Table 10. Example of PCE savings distribution from integrating renewables & excess capacity for heat

Scenario 7-High Penetration Wind-Diesel		
For eligible customers (37% of all kWh sold)		**Savings distribution**
Production cost savings/kWh	$0.40	
PCE eligible kWh	$0.380	
PCE program savings/kWh (based on 95%covered by PCE program)	$0.020	
Total PCE program savings	$134,203	36%
Customer savings (based on 5% not covered by PCE program)	$0.020	
Total eligible customer savings	$7,063	2%
For non eligible customers, 100% savings (63% of all kWh sold)		
Non-eligible customers' savings/kWh	$0.40	
Total non-eligible kWh	591,183	
Total non-eligible customer savings	$236,473	63%
Total production savings from renewable energy integration	$377,740	

Source: Alaska Energy Authority, PCE program data.

In summary, the current PCE formula arguably becomes a disincentive against energy efficiency and renewable energy integration in relation to all of these issues.

Alternative PCE funding formulas

One of the objectives of this research is to analyze whether there are alternate funding formula structures to calculate PCE payments that would eliminate or reduce the energy efficiency and renewable energy disincentives created by the current PCE funding formula, and ideally, provide market incentives to encourage energy efficiency and renewable generation. [27] This goal is congruent with international energy subsidy reform guidelines published by the United Nations in which it states that "a good subsidy is one that enhances access to sustainable modern energy or has a positive impact on the environment, while sustaining incentives for efficiency delivery and consumption" (UNEP, 2008). These guidelines suggest basic principles needed in implementing reforms to existing programs. Namely, a subsidy should be well-targeted, efficient, practical, and transparent among other features.

When analyzing alternative funding formulas and comparing them to the current PCE funding formula, we used the following key parameters to evaluate whether the alternatives are improvements over the current system:

- ✓ Improves market signals
- ✓ Does not penalize increased energy efficiency or integration of renewable energy
- ✓ Has an equitable distribution across households

[27] In order to analyze the programmatic effect of potential changes in funding formula structures from the current structure, the eligible kilowatt-hours cap was held constant at 500 kWh per residential customer per month.

- ✓ Does not decrease the current distribution of funds to a community
- ✓ Simplifies administration for utilities and state agencies and enhances understanding by customers/rate payers
- ✓ Simplifies formula and information needs for implementation

In addition, previous research illustrates the impacts different types of economic assistance structures have on incentives. In 1987, an important conceptual review of potential structures of the PCE program was completed for the Governor's Energy Policy Task Force (Mitchell 1987). In this review, Mr. Mitchell analyzed and ranked various program structures and funding formulas with respect to maintaining utility and customer market signals and economic incentives (Table 11). This research evaluated incentive effects of a subsidy program by analyzing what proportion of electricity generation cost savings are kept by the utility under various program structures (Table 11, Utility Incentive). Customer incentives were evaluated by analyzing the proportion of cost reductions from energy conservation measures kept by the customer (Table 11, Customer Incentive). According to Mr. Mitchell's research, under a Fixed Payment Formula utilities are able to keep 100% of the benefit from generation cost savings, and customers are able to keep 100% of the benefits from savings through energy conservation measures they implement. Our research extends this analysis by defining specific formulas and using PCE data to model their potential impacts to PCE recipients. We modeled specific potential formulas to estimate different outcomes compared to the current PCE formula based on the criteria listed above.

Table 11. Summary of incentive effects

Program	Utility Incentive	Customer Incentive
PCE Rate [current]	13%	33%
PCE Formula Rate	100%	significantly less than 33%
Shared Savings Rate	58%	less than 33%
Baseline Rate	58%	75%
Postage Stamp Rate	8%	33%
Fixed Payment Formula	100%	100%
Fixed Payment Cost	58%	100%
Fixed Payment Formula - No Excess	100%	75%

Source: Table recreated from *The Effect of Electricity Subsidy Programs on the Economic Incentives for Improving Generation and End-Use Technologies, A comparison of Power Cost Equalization and Alternatives*; prepared for the Governor's Energy Policy Task Force, Alan Mitchell, 1987.

The current PCE program uses a rate/cost formula to calculate PCE reimbursement rates. The key variables in the current PCE formula for calculating rates are non-fuel costs, fuel prices and consumption. Under a formula rate program, the calculated rate is then applied to the eligible amount of kilowatt-hours to determine the PCE payment.

In contrast, a Fixed Payment formula provides a payment per given time period independent of rates and consumption. The fixed payment, however, can vary by community and be determined based on the differences in prices customers pay or the cost of producing electricity.

We examined six potential formula structures and then did sensitivity analysis by changing the parameters resulting in fifteen possible scenarios. The examined formulas included a: cost index, rate index, combined cost and consumption index, geographic price differential index, life line fixed payment, and postage stamp rates.[28] We found that the cost and index formulas had the potential to slightly improve market signals but did not provide much improvement over the current PCE funding formula based on review parameters. The formulas with the greatest potential and review criteria are shown in Table 12.[29]

Table 12. Evaluation of reviewed formula structures based on reforming criteria

Structure	Improved market signals	Does not penalize efficiency or renewables	No large price increase to households	Equitable distribution	Simplify administration	Simplify formula
Seasonal Fixed Payment Formula	Y	Y	Y	Y	Y	Y
Rate and Consumption Index Formula	Y, but dampened	Y - RE, N-EE	Y	Y	marginal	N
Fixed Payment Formula, Rate	Unclear	Unclear	N	Y	marginal	N
Fixed Payment Formula, Cost	Unclear	Unclear	N	Y	N	N

Source: PCE monthly program data CY 2010 and authors' calculations.

Seasonal Fixed Payment Formula

Among alternate PCE structures we analyzed for this report, one deserves particular attention. We developed a fixed payment formula based on the per gallon price of fuel in a community, a generation efficiency rate, and the mean seasonal household monthly kWh consumption level. A fixed payment is calculated by dividing the price per gallon of fuel oil in a particular community (regardless of whether they generate their power with fuel oil or other sources; fuel price is used as a proxy to measure how

[28] Other potential structures were also tested, but did not yield results due to data issues or invalid assumptions. For example, we attempted to model a formula rate structured based on fuel cost and State of Alaska geographic cost differential used to set pay differentials in different regions of Alaska. However, the geographic differentials are based on too few communities and do not include many PCE communities. We also attempted to model a formula that accounted for high overhead or lack of economies of scale. However, many communities, reviewing the relationship between rates and levels of electricity production, had no clear relationship. This is probably due to the fact that most PCE communities are operating a production levels too low to capture any economies of scale. For information on a postage stamp rate, see Fay and Villalobos, 2012, All-Alaska Rate Analysis.

[29] Details of these analyses are available upon request.

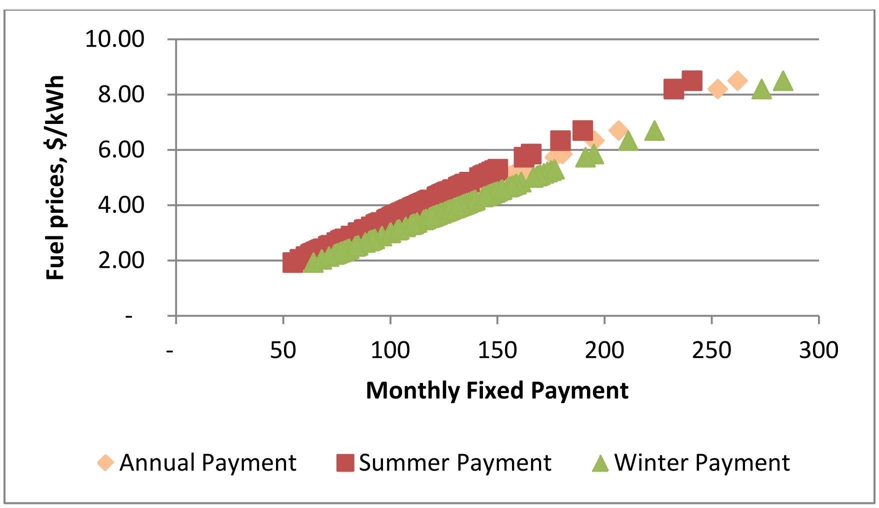
much more costly it is to generate in one village compared to others) by a fixed generation efficiency of 14 kWh per gallon. This factor is then multiplied by the seasonal median monthly residential consumption.

[(Fuel price $/gallon) ÷ (kWh/gal)] *Average monthly consumption per season

The resulting fixed payment would be applied to the rate payer's bill every month and paid to the utility. However, to accommodate changes in seasonal consumption needs, the fixed payment would change by season so that during the summer months (April-September) the customer receives a lower fixed payment reflecting lower seasonal consumption levels, and in the winter months (October-March) the fixed payment would be higher reflecting higher winter consumption[30].

Applying this formula results in similar total residential disbursements as the current PCE funding formula. However, because the payment does not depend on the amount of fuel consumed and the customer receives payment regardless of consumption or rates, household and generation energy efficiency and renewable energy incentives are reestablished. If the utility is able to produce energy at lower cost through gains in demand or supply side efficiency or using renewable energy, the benefits to the utility and customer increases. Figure 10 shows how the communities with higher fuel prices will receive higher monthly payments.

Figure 10. Average annual PCE payment with respect to fuel prices



Source: PCE monthly program data CY 2010 and authors' calculations.

This formula structure is particularly simple and significantly decreases the administrative burden rural utilities face to file for PCE payments with the RCA and AEA. Because of its simplicity, the administration

[30] Appendix G shows CY 2009 PCE program data including residential rates, PCE level and fuel prices; it also shows the estimated monthly payments per customer under the current PCE formula and the Fixed Payment Seasonal formula.

of the program could potentially be given to a single agency resulting in lower administrative costs to the state.[31]

An important feature of this potential Seasonal Fixed Payment formula is that if the customer has an electric bill lower than the fixed payment, the balance could be carried over to future months as a credit. At the end of the year if the customer has a net credit, there are a number of options that the program could offer to customers. For example, the customer could use the credit to purchase more energy efficient appliances and/or lighting products, transfer the credit to a relative in the village who may need it, or simply carry it forward to the following year.

Table 13. Actual and estimated residential disbursements by funding formula, CY 2009

Structure	Description	Estimated Total Disbursement (Million)	Average Payment per Residential Customer
Current PCE Formula		$26.4	$125
Current PCE Formula	All customers @ 500 kWh	$45.5	$184
Rate-Consumption Index	@ current consumption	$28.0	$128
	@ fixed 250 kWh/month	$24.3	$94
	@ fixed 500 kWh/month	$48.5	$187
Fixed Payment Formula, Rate	100% of mean consumption	$17.8	$67
	50% of mean consumption	$8.8	$33
Fixed Payment Formula, Costs	100% of mean consumption	$9.4	$137
	50% of mean consumption	$7.0	$68
	100% of mean consumption, RCA	$12.0	$192
	50% of mean consumption, RCA	$5.9	$96
Seasonal Fixed Payment Formula	@ 14 kWh/gallon Summer 340 kWh/customer/month Winter 400 kWh/customer/month	$29.2	Summer $95 Winter $111 Annual $103
	@ 12 kWh/gallon	$34.1	Summer $110 Winter $130 Annual $120

Source: PCE monthly program data CY 2010 and authors' calculations.

This Seasonal Fixed Payment formula is consistent with previous research findings showing that decoupling the funding formula structure from fuel costs helps remove incentive barriers to energy efficiency and renewable energy development. However, this formula represents preliminary analysis on a potential new formula design. Although fuel prices may reflect differences in generation costs across rural utilities, the suggested formula does not account for differences in costs resulting from utility size and/or non fuel costs. As previously explained in this report, lack of economies of scale result in fixed costs making up a larger proportion of kWh production costs for smaller rural utilities.

[31] Additional research is needed to estimate and analyzed the amount and areas where savings can occur.

Additional in-depth research is required to determine an effective way to account for that variability among utilities. In addition, a preliminary review of PCE data shows that rates and costs do not seem to have an expected clear relationship which may be a consequence of lack of data availability or the complexities of tracking costs as utilities may receive assistance from other state programs (e.g. for maintenance, infrastructure upgrades).

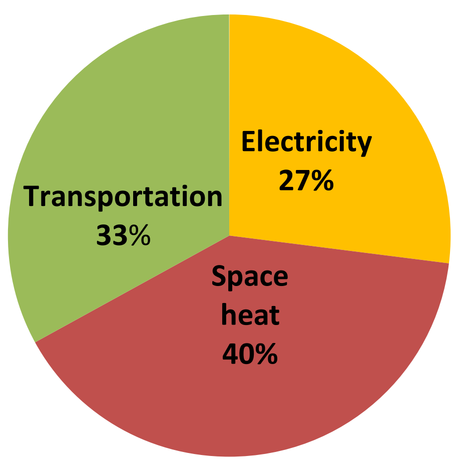
This formula design relies on only one cost variability proxy (fuel price), however fuel prices are volatile and this volatility may be passed along in the formula because as currently constructed there is no mechanism to smooth potential volatility. This could be addressed by using rolling averages of fuel prices. However, the research presented in this paper suggests that decoupling can be achieved and incentive barriers removed.

Policy considerations

The PCE program is critical to many rural residents; restructuring the program to improve its effectiveness and efficiency is complex. There are no simple solutions to addressing the problems of high costs that rural utilities and residents face. In seeking solutions to these issues, it is important to approach the PCE program in the context of total energy use in rural Alaska. The PCE program alone has not and will not solve the fundamental issues that result in high cost energy and the impacts this has on rural residents.

Most PCE communities depend on fuel oil for both electricity generation and space heating. Consequently, high fuel oil prices increase both the cost of electricity and space heating, thus magnifying the pressure on households. Putting electricity consumption in context, space heating is the largest share of household energy expenses (40%), followed by transportation (33%), Figure 11, (Colt, 2011). PCE provides important relief on electricity rates; however only about 27% of fuel consumed in PCE communities is used to produce electricity (Figure 11). On top of this, only about 30% of kWh used in eligible communities is affected by PCE effective rates—so the PCE program only touches about 10% of the energy picture in rural Alaska.

Figure 11. Energy use in surveyed PCE communities by category



Source: Energy Use the Big Efficiency Picture. Presentation at the Alaska Rural Energy Conference by Steve Colt (2011), ISER.

This composition of energy use is reflected in the course of this and other rural energy research and interviews in which we found a high level of “energy insecurity” expressed by rural residents. Given volatile and unpredictable energy prices and past changes in legislative funding of the PCE program, many residents are understandably concerned about the ability to stay warm, gather subsistence resources and keep the lights on. Reviewing and improving rural energy programs must be done from a “whole village energy” perspective.

From a whole village perspective, one of the first objectives is to assist rural residents to be as energy efficient as possible to reduce the impacts of energy price volatility while maintaining quality of life and reducing anxiety over energy security. In addition to the current on-going weatherization efforts in rural communities, energy efficiency and conservation could be maximized to fulfill this objective. This does not mean that new efficiency and conservation programs are needed but instead existing programs can be better coordinated and delivered—when a home or building is weatherized, it can also be retrofitted to improve electrical efficiency. Commercial and public building can be weatherized and electrical energy efficiency measures installed simultaneously with residential housing weatherization and rebate programs.

A recent weatherization and electrical retrofit on 13 community buildings and four teacher housing units in Nightmute was done as a concurrent effort. This more comprehensive and integrated effort resulted in estimated annual electric power savings of 59% and thermal energy savings of 56% (Butler, 2010). It is likely residential buildings experience similar savings and whole village efforts could produce substantial energy saving for residents, public buildings, businesses and schools. Realizing these substantial demand side efficiency gains is a first step to solving the challenge of high rural energy costs for residents. It logically proceeds before addressing supply side generation, either fossil fuel, renewable or disaggregated, because the generation capacity would be inappropriately sized for the demand and would continue to overcapitalize generation and waste high priced fuel. These actions could take place in concert with the assistance that a re-formulated PCE program can provide.

PCE Funding Formula

After reviewing possible alternatives, the Seasonal Fixed Payment Formula seems to be a viable option to support rural residents; it removes or decreases current barriers or disincentives found in the current PCE funding formula. Its simplicity could also translate into administrative savings that could be repurposed to support efficiency and demand side solutions.

Centralized versus disaggregated generation

Power Cost Equalization eligibility depends on having a centralized utility. As a result, for some of the smallest communities there is an incentive to over capitalize electricity generation despite the potential for less capital intensive solutions. Institutional mechanisms that emphasize conventional solutions “…raises the propensity to ignore decentralized supply options” (Hourcade & Colombier, 1990). For communities with very small populations, a traditional centralized utility may translate to higher cost power as compared to disaggregated generation because of the added cost of administration, transmission lines, and building necessary redundancy into the system among other costs that could potentially be avoided through disaggregated generation, though each individual household may experience differing degrees of reliability and access to power. If economic assistance for electricity was not restricted to centralized utilities, villages could organize through their local tribes or government to create mechanisms to support current or alternative ways of disaggregated generation that may be less costly to operate. It may also result in job creation that can be more compatible with the subsistence life styles of many rural residents and potentially more sustainable in the long run. Further research is necessary to determine the population size and other circumstances at which a rural village may be able to access lower cost electricity through disaggregated self- generation rather than opting to run a centralized utility.

Expanding eligibility to commercial customers

In the early years of the PCE program, commercial customers were eligible to receive PCE; it was not until FY2000 that commercial customers became ineligible primarily as a program cost containment measure. Commercial rate payers were eligible to receive PCE assistance for the same amount of kilowatt-hours as residential customers (700 kWh per month in 1999, the last year they received assistance).

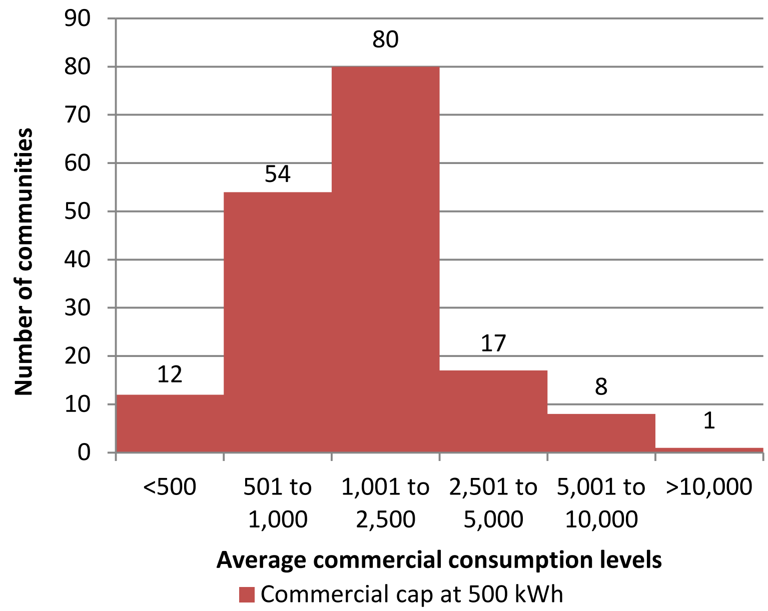
The sharp increase in fuel prices since 2008 has aggravated many challenges rural residents face in keeping their communities viable places to live. During the 2011 Alaska Rural Energy Conference, a number of participants raised the topic of expanding eligibility of PCE to include commercial customers to help lower the risk of businesses failing due to the economic pressure from high energy prices. Based on 2009 PCE program data on the number of commercial customers and kilowatt-hours sold, we estimated how much it would cost to expand eligibility to commercial customers. The estimates were calculated at eligibility of 700 kWh per month (level when commercial customers were last eligible) and at 500kWh per month (current residential eligibility level).

Under the current PCE program structure, funding for disbursements would have to increase about $11 million or 35%, to provide assistance to commercial customers at the 500 kWh per month level. If eligibility was available for 700 kWh per month, funding would have to increase about $15 million, or 47%. Average commercial customers' consumption in 93% of PCE communities would exceed the maximum eligibility cap of 500 kWh per month. At the 700 kWh per month cap, the average commercial customers' consumption would exceed the 700 kWh per month eligibility cap in about 77% of PCE communities.

At the 500 kWh level in about 38% of communities, most commercial customers would see relief on half or more of their total electric consumption. In 60% of communities, most commercial customers would see relief on half or more of their total electric consumption at the 700 kWh level. Figure 12 and Figure 13 shows the number of communities with different average levels of electricity consumption by commercial customers under the two kWh caps.

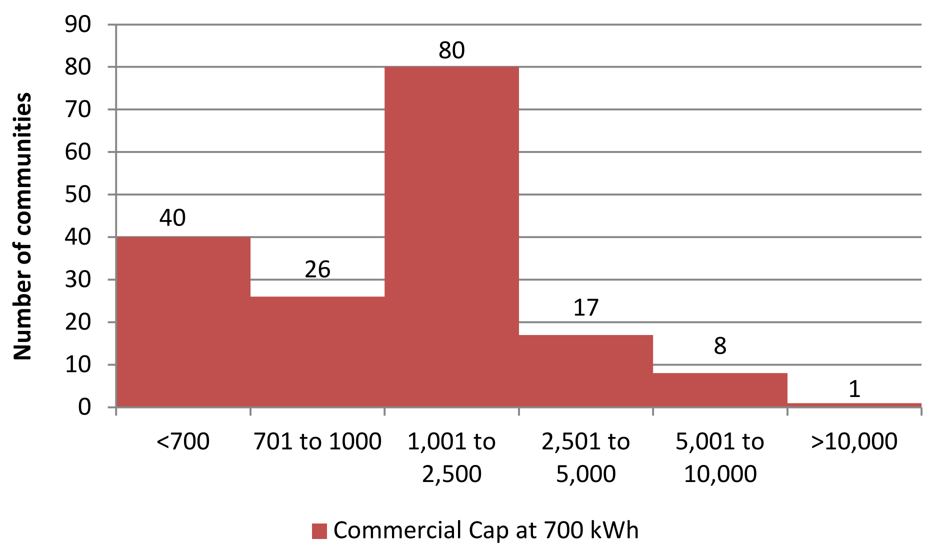
Our analyses show that renewable energy project development primarily benefits commercial customers and those not eligible for PCE. So increased renewable energy development and energy efficiency improvements should reduce the need for PCE for commercial customers.

Figure 12. Average commercial consumption levels in PCE communities (500 kWh cap)



Source: PCE monthly program data CY 2010 and authors' calculations.

Figure 13. Average commercial consumption levels in PCE communities (700 kWh cap)



Source: PCE monthly program data CY 2010 and authors' calculations.

Increasing residential customer eligibility cap to 700 kWh per month

In the spirit of providing additional assistance to households, recently introduced House Bill 294 proposes to increase the residential customer eligibility ceiling to the 1999 level of 700 kWh per month. Appropriate to the discussion of raising the PCE ceiling are two important questions. Does increasing the ceiling benefit those who are targeted by the change? And, what is the additional cost to the state?

In a previous section of the report we extensively discussed consumption patterns among PCE communities and their variability within and by region. This review clearly shows that on average residential consumers in most PCE communities do not consume all of their eligible kilowatt-hours. In CY 2009 total PCE disbursements were about $31 million; however, if all eligible residential customers consumed all their eligible 500 kWh, year round disbursements would have been about $45.5 million. Hence, in effect the lower levels of consumption found among PCE customers lowers current program costs by over 30% annually.

Increasing the eligibility threshold is not likely to provide substantial additional assistance to rural households. Limited levels of consumption among PCE communities suggest that given the current levels of PCE assistance, it is the income and/or other effects that have a larger impact on their ability to consume more electricity. Customers who would benefit the most from an increased eligibility cap are residential customers with lower effective rates who are already consuming significantly higher amounts of electricity each month, residential customers with higher incomes that consume more electricity than the average customer, or a small portion of customers that due to moderate effective rate and income levels are able to increase their electricity consumption due to seasonal changes during the winter. This phenomenon is well documented in the literature: “The strife to ensure equal access to electricity for all citizens through subsidized rates, increases the consumption by higher-income consumers, and does not guarantee access to basic services by the poorest residents” (Hourcade & Colombier, 1990). Consequently, it is an inaccurate assumption that increasing the eligibility cap would translate into extensive economic relief for all PCE eligible customers, or those who need the relief the most.

We estimated the increase in total disbursements to residential customers in CY2009 if the eligibility cap had been 700 kWh per month. Raising the cap would have increased disbursements to almost $34 million from $31 million, or less than 8%. However, increasing the kWh ceiling would also increase the potential liability to the state by 40% to about $63 million, if all residential customers consumed up to the higher cap.

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Appendix A. PCE funding levels per year

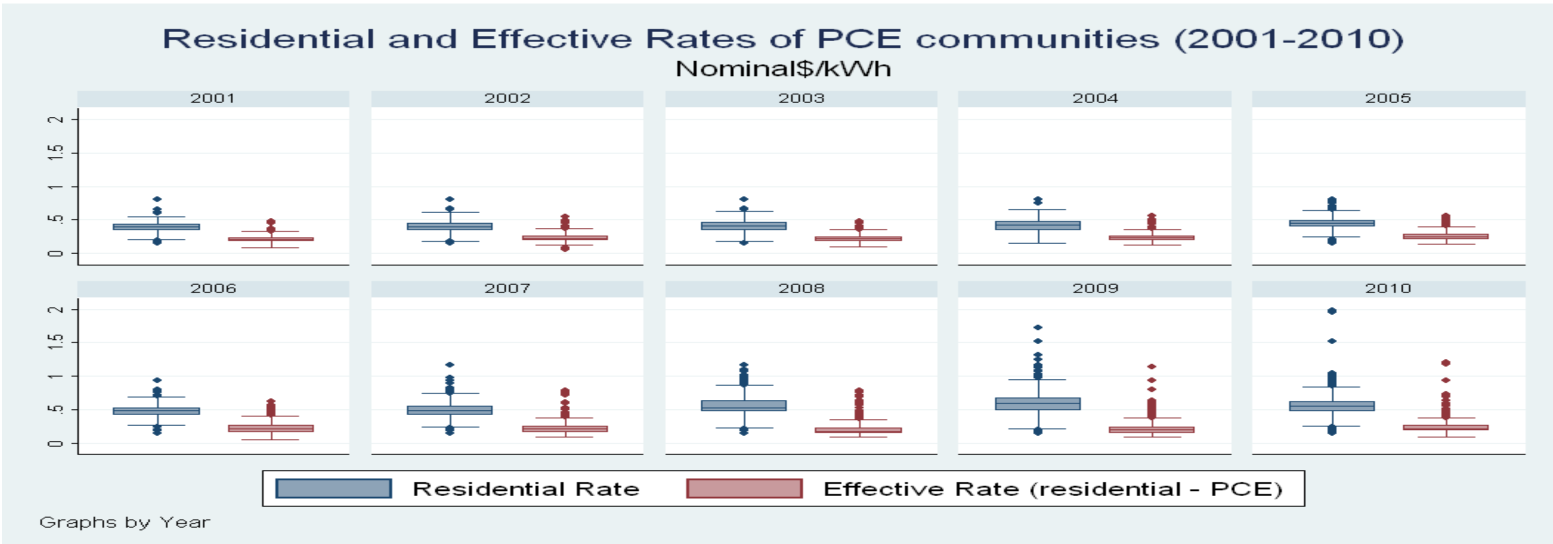
Program	Fiscal Year	Average Annual PCE Funding Level	PCE Funding Level Detail							
			PCE Level	No. of Months	PCE Level	No. of Months	PCE Level	No. of Months	PCE Level	No. of Months
PPCA	1981	100.00%	100%	12						
PCA	1982	100.00%	100%	12						
PCA	1983	100.00%	100%	12						
PCA	1984	100.00%	100%	12						
PCA PCE	1985	100.00%	100%	12						
PCE	1986	100.00%	100%	12						
PCE	1987	100.00%	100%	12						
PCE	1988	100.00%	100%	12						
PCE	1989	100.00%	100%	12						
PCE	1990	100.00%	100%	12						
PCE	1991	100.00%	100%	12						
PCE	1992	81.67%	100%	1	80%	11				
PCE	1993	89.17%	80%	1	90%	11				
PCE	1994	95.00%	90%	2	95%	8	100%	2		
PCE	1995	97.50%	100%	10	85%	2				
PCE	1996	97.50%	85%	2	100%	10				
PCE	1997	85.00%	85%	12						
PCE	1998	85.00%	85%	12						
PCE	1999	83.08%	85%	10	73.5%	2				
PCE	2000	100.00%	100%	12						
PCE	2001	97.83%	100%	11	74%	1				
PCE	2002	80.33%	92%	7	80%	4	66%	1		
PCE	2003	86.17%	84%	8	90%	3	92%	1		
PCE	2004	82.25%	92%	3	83%	6	75%	2	63%	1
PCE	2005	72.08%	81%	2	76%	5	65%	4	63%	1
PCE	2006	88.17%	81%	4	78%	3	100%	5		
PCE	2007	94.50%	100%	6	89%	6				
PCE	2008	100.00%	100%	12						
PCE	2009	100.00%	100%	12						
PCE	2010	100.00%	100%	12						

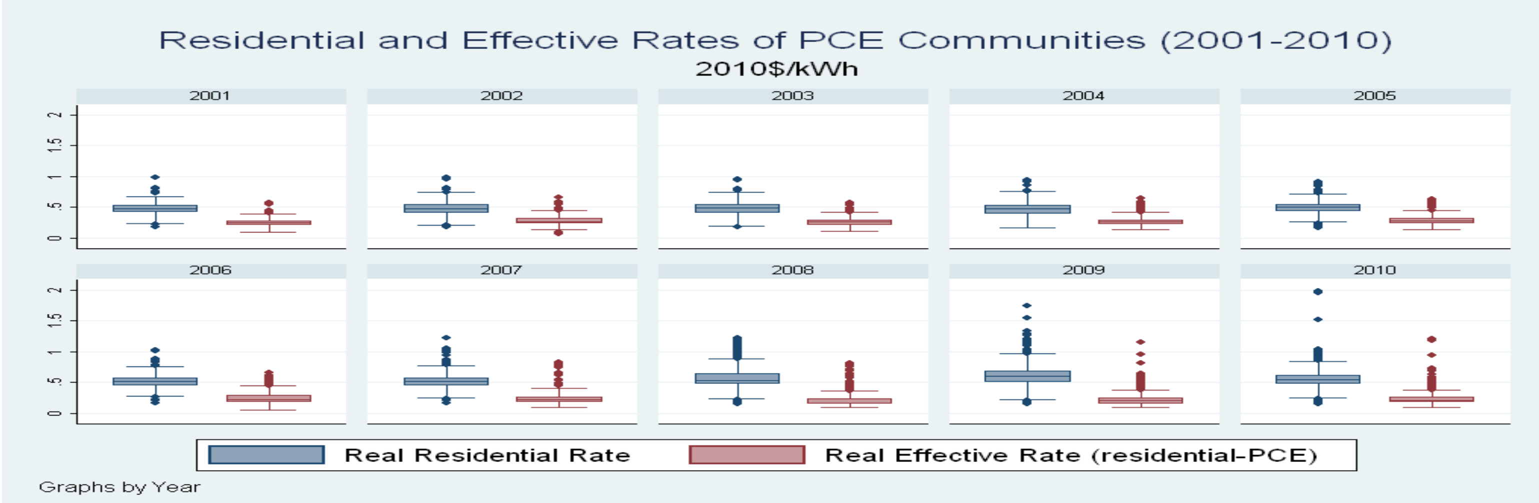
Source: Statistical Reports of the Power Cost Equalization Program 1988-2010

Appendix B. PCE appropriations and disbursements over time

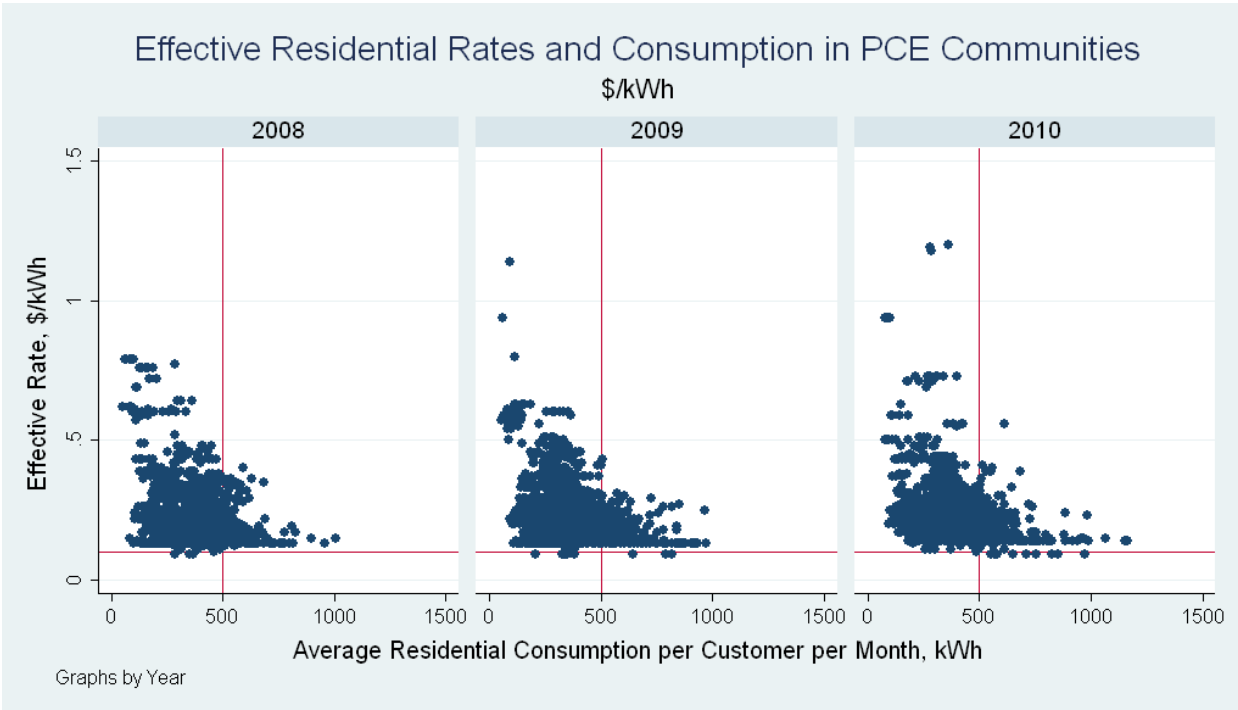
Program	Fiscal Year	Appropriations ($)	Total Disbursements ($)
PPCA	1981	2,657,600	2,183,168
PCA	1982	9,300,000	6,419,408
PCA	1983	8,300,000	8,327,152
PCA	1984	8,300,000	8,740,820
PCA/PCE	1985	19,100,000	13,800,868
PCE	1986	21,700,000	17,785,390
PCE	1987	13,840,299	16,771,338
PCE	1988	15,067,900	17,018,680
PCE	1989	19,724,000	17,104,631
PCE	1990	16,814,000	17,785,256
PCE	1991	16,912,100	19,607,435
PCE	1992	15,029,700	15,731,165
PCE	1993	18,026,700	17,341,042
PCE	1994	17,920,000	17,516,024
PCE	1995	18,635,000	18,493,448
PCE	1996	19,385,600	19,201,515
PCE	1997	18,500,000	17,906,275
PCE	1998	18,700,000	18,503,992
PCE	1999	18,050,000	17,949,524
PCE	2000	15,700,000	14,415,676
PCE	2001	17,090,222	17,076,203
PCE	2002	15,700,000	15,469,105
PCE	2003	15,700,000	15,448,480
PCE	2004	15,700,000	15,617,225
PCE	2005	15,700,000	15,370,599
PCE	2006	22,020,000	21,494,137
PCE	2007	25,619,000	25,437,093
PCE	2008	28,560,000	28,137,549
PCE	2009	38,500,000	37,029,584
PCE	2010	37,660,000	30,627,339
PCE	2011		

Appendix C. Residential and effective rates of PCE communities, 2001-2010





Appendix D. Effective residential rates and consumption of electricity in PCE communities, 2008-2010



Appendix F. PCE communities characteristics of importance as factors of electricity production and demand[32]

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Adak	Aleutians West (CA)	0.73	0.23	3.55	5.47	258	105	2*	64,453*
Akiachak	Bethel (CA)	0.64	0.24	3.72	15.05	306	624	4	41,459
Akiak	Bethel (CA)	0.64	0.32	4.55	12.45	238	339	4	30,372
Akutan	Aleutians East	0.33	0.14	3.22	8.89	394	812	2	39,049
Alakanuk	Wade Hampton (CA)	0.63	0.20	3.90	13.55	417	695	5	30,483
Allakaket	Yukon-Koyukuk (CA)	0.71	0.19	4.38	13.56	237	105	2*	23,824*
Ambler	Northwest Arctic	0.76	0.21	4.47	14.13	398	258	4	50,330
Anaktuvuk Pass	North Slope	0.16	0.14	5.20	11.52	604	309	3	60,743
Angoon	Hoonah-Angoon (CA)								

[32] Income and household data are originally sourced from the Internal Revenue Service for the Viable Business Enterprises for Rural Alaska project by ISER and other partners (http://ced.uaa.alaska.edu/vibes/VIBESsummary.pdf). The Income and household data represent calendar year of 2004 and adjusted to 2010 dollars. Although more recent data is available through the U.S. Census Bureau America Community Survey (ACS), we present older data because we believe it is more accurate. ACS data is available as a 5 year average and is the result extrapolation of sampled data. However, due to the challenges of small samples in Alaska, ACS tends to have very large margin of errors severely limiting its value. When data from the VIBES project was not available, ACS data is presented; this is indicated by the asterisks next to the data point.

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
		0.48	0.20	2.78	14.08	412	450	3	34,550
Aniak	Bethel (CA)	0.75	0.27	3.62	13.39	452	494	3	48,450
Anvik	Yukon-Koyukuk (CA)	0.68	0.19	4.17	11.92	327	72	3	24,587
Atka	Aleutians West (CA)	0.71	0.24	4.19	10.79	395	63	3	35,796
Atmautluak	Bethel (CA)	0.78	0.37	3.59	6.98	340	269	5	43,871
Atqasuk	North Slope	0.19	0.18	3.00	8.39	783	212	4	77,065
Beaver	Yukon-Koyukuk (CA)	0.56	0.14	3.80		195	73	3	33,264
Bethel	Bethel (CA)	0.50	0.16	5.05	13.76	505	5,966	3	66,321
Bettles	Yukon-Koyukuk (CA)	0.62	0.19	2.65	12.13	382	13	3	57,128
Brevig Mission	Nome (CA)	0.60	0.19	4.00	14.21	418	358	4	25,310
Buckland	Northwest Arctic	0.53	0.23	5.00	11.42	523	392	5	44,352
Central	Yukon-Koyukuk (CA)	0.61	0.31	2.27	10.82	167	96	2*	14,278*
Chalkyitsik	Yukon-Koyukuk (CA)	0.97	0.59	4.18	10.59	123	71	2	18,801
Chefornak	Bethel (CA)	0.64	0.26	4.13	12.95	424	430	5	41,139
Chenega	Valdez-Cordova (CA)								

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Bay		0.47	0.17	3.30	6.64	343	80	4	62,190
Chevak	Wade Hampton (CA)	0.66	0.19	4.03	12.87	430	931	5	31,095
Chignik	Lake and Peninsula	0.52	0.18	2.75	11.34	286	84	3	39,628
Chignik Lagoon	Lake and Peninsula	0.45	0.15	3.93	11.60	428	82	3	106,789
Chignik Lake	Lake and Peninsula	0.59	0.19	2.80		316	77	4	47,967
Chilkat Valley	Haines	0.48	0.20	3.20		292			43,855*
Chistochina	Valdez-Cordova (CA)	0.52	0.19	2.31	11.50	292	93	2*	47,040*
Chitina	Valdez-Cordova (CA)	0.55	0.25	2.73	13.25	277	133	2*	12,763*
Chuathbaluk	Bethel (CA)	1.01	0.26	5.15	11.53	217	107	4	39,669
Circle	Yukon-Koyukuk (CA)	0.68	0.19	2.43	10.63	300	115	2*	15,060*
Coffman Cove	Prince of Wales-Hyder (CA)	0.43	0.18	2.51	13.31	306	207	3	50,619
Cold Bay	Aleutians East	0.63	0.18	3.65	13.54	405	110	2	64,504
Cordova	Valdez-Cordova (CA)	0.34	0.24	2.23	13.40	517	2,266	2	57,983
Craig	Prince of Wales-Hyder (CA)	0.21	0.16	2.30	10.36	504	1,194	3	52,410
Crooked	Bethel (CA)								

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Creek		1.01	0.26	5.25	11.77	282	106	4	20,248
Deering	Northwest Arctic	0.78	0.35	4.71	12.64	381	126	3	38,567
Dillingham	Dillingham (CA)	0.44	0.16	3.60	15.20	475	2,245	3	59,538
Diomede	Nome (CA)	0.61	0.14	5.85	9.88	258	118	3	27,479
Dot Lake	Southeast Fairbanks (CA)	0.33	0.17	2.08		344	8	1*	38,461*
Eagle	Southeast Fairbanks (CA)	0.63	0.19	2.88	12.30	209	82	2*	25,047*
Eek	Bethel (CA)	0.69	0.20	3.83	12.03	269	283	4	20,248
Egegik	Lake and Peninsula	0.93	0.36	4.30	9.62	265	73	3	53,223
Ekwok	Dillingham (CA)	0.51	0.14	3.70		338	117	3	18,801
Elfin Cove	Hoonah-Angoon (CA)	0.57	0.18	4.42	12.86	182	23	2	39,049
Elim	Nome (CA)	0.61	0.19	4.07	13.67	393	302	4	46,488
Emmonak	Wade Hampton (CA)	0.64	0.20	3.90	13.51	442	766	4	38,085
Fort Yukon	Yukon-Koyukuk (CA)	0.61	0.22	3.78	14.12	275	604	3	33,987
Galena	Yukon-Koyukuk (CA)	0.57	0.23	4.30	13.03	365	539	3	70,722
Gambell	Nome (CA)								

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
		0.62	0.19	3.93	13.38	370	680	4	36,397
Golovin	Nome (CA)	0.71	0.19	5.10	12.23	319	154	3	36,880
Goodnews Bay	Bethel (CA)	0.64	0.20	3.83	12.91	352	247	3	18,801
Grayling	Yukon-Koyukuk (CA)	0.71	0.21	4.17	11.83	294	182	4	25,310
Gustavus	Hoonah-Angoon (CA)	0.58	0.28	2.71	15.47	159	464	2	40,225
Haines	Haines	0.21	0.15	3.13	13.24	450	1,673	2*	44,877*
Healy Lake	Southeast Fairbanks (CA)	0.66	0.24	2.53	9.43	269	8	2*	11,2953 *
Hollis	Prince of Wales-Hyder (CA)	0.21	0.16	2.80		401	118	2*	27,866*
Holy Cross	Yukon-Koyukuk (CA)	0.68	0.19	4.10	12.63	322	186	4	25,310
Hoonah	Hoonah-Angoon (CA)	0.48	0.20	2.40	14.27	424	762	3	45,156
Hooper Bay	Wade Hampton (CA)	0.62	0.19	4.00	13.53	338	1,054	4	30,854
Hughes	Yukon-Koyukuk (CA)	0.72	0.34	4.45	12.76	291	71	3	28,202
Huslia	Yukon-Koyukuk (CA)	0.64	0.20	4.13		403	267	3	31,239
Hydaburg	Prince of Wales-Hyder (CA)	0.21	0.16	2.88	(3.84)	505	386	3	36,591

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Igiugig	Lake and Peninsula	0.75	0.17	6.33	10.65	314	39	3	25,165
Kake	Petersburg (CA)	0.48	0.20	2.71	13.34	374	578	3	45,868
Kaktovik	North Slope	0.18	0.16	3.70	15.78	662	245	3	64,359
Kalskag	Bethel (CA)	0.60	0.19	3.97	13.42	396	196	4	32,782
Kaltag	Yukon-Koyukuk (CA)	0.64	0.19	4.03	14.23	338	187	3	33,747
Karluk	Kodiak Island	0.61	0.14	3.58	11.55	470	38	3	22,176
Kasigluk	Bethel (CA)	0.55	0.18	3.97	13.53	452	548	5	36,446
Kiana	Northwest Arctic	0.69	0.19	4.40	12.75	423	356	4	45,920
King Cove	Aleutians East	0.25	0.15	2.36	11.13	425	824	3	53,099
Kipnuk	Bethel (CA)	0.65	0.26	3.65	6.37	416	640	5	39,772
Kivalina	Northwest Arctic	0.71	0.20	4.40	12.78	497	370	5	35,674
Klawock	Prince of Wales-Hyder (CA)	0.21	0.16	2.85		520	723	3	40,496
Klukwan	Hoonah-Angoon (CA)	0.48	0.20	3.20		390	76	2*	27,760*
Kobuk	Northwest Arctic	0.88	0.30			422	133	4	35,578

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Kokhanok	Lake and Peninsula	0.92	0.27	4.57	12.15	337	170	3	22,658
Koliganek	Dillingham (CA)	0.51	0.14	5.06	8.36	273	185	3	51,583
Kongiganak	Bethel (CA)	0.56	0.26	4.03	12.72	452	440	5	38,471
Kotlik	Wade Hampton (CA)	0.59	0.19	3.67	13.57	455	574	5	43,677
Kotzebue	Northwest Arctic	0.48	0.18	3.94	15.16	650	3,331	3	66,138
Koyuk	Nome (CA)	0.63	0.19	4.07	13.85	471	338	4	35,193
Koyukuk	Yukon-Koyukuk (CA)	0.46	0.15	4.00		181	99	3	22,417
Kwethluk	Bethel (CA)	0.53	0.24	3.73	12.44	292	692	5	29,408
Kwigillingok	Bethel (CA)	0.51	0.17	3.90	13.23	446	330	5	41,942
Larsen Bay	Kodiak Island	0.41	0.22	3.59	11.56	301	85	3	47,244
Levelock	Lake and Peninsula	0.72	0.13	8.50		190	95	3	21,694
Lime Village	Bethel (CA)	1.27	0.67	8.20	5.62	82	24	1*	14,039*
Lower Kalskag	Bethel (CA)	0.60	0.19	3.97		299	271	4	29,648
Manley Hot Springs	Yukon-Koyukuk (CA)	1.05	0.27	2.38	10.83	122	85	4*	76,260*

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Manokotak	Dillingham (CA)	0.51	0.19	3.88	12.31	334	422	4	31,095
Marshall	Wade Hampton (CA)	0.64	0.20	3.57	14.27	433	396	4	38,085
McGrath	Yukon-Koyukuk (CA)	0.61	0.17	3.82	13.19	363	327	3	49,816
Mekoryuk	Bethel (CA)	0.66	0.19	3.70	13.08	270	177	3	35,674
Mentasta Lake	Valdez-Cordova (CA)	0.53	0.19	2.33	12.35	274	122	3*	22,335*
Minto	Yukon-Koyukuk (CA)	0.59	0.20	3.47	12.67	327	203	3*	32,227*
Mountain Village	Wade Hampton (CA)	0.61	0.20	3.93	14.63	428	806	4	36,157
Naknek	Bristol Bay	0.44	0.17	3.50	15.15	397	545	3	61,776
Napakiak	Bethel (CA)	0.98	0.25		2.69	307	345	4	33,264
Napaskiak	Bethel (CA)	0.61	0.18	3.76	8.44	448	410	5	36,800
Naukati Bay	Prince of Wales-Hyder (CA)	0.45	0.18	2.55	12.27	404	111	2	31,818
Nelson Lagoon	Aleutians East	0.66	0.27	4.32	11.98	304	58	3	50,619
New Stuyahok	Dillingham (CA)	0.63	0.19	4.13	12.79	430	510	4	30,131
Newtok	Bethel (CA)	0.81	0.40	4.68	10.25	308	351	5	37,242

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Nightmute	Bethel (CA)	0.55	0.18	4.03		447	279	4	41,581
Nikolai	Yukon-Koyukuk (CA)	0.81	0.42	4.83	3.19	359	86	3	17,355
Nikolski	Aleutians West (CA)	0.61	0.22	4.50	9.72	338	23	3	44,834
Noatak	Northwest Arctic	0.81	0.19	6.70	13.86	561	490	4	35,674
Nome	Nome (CA)	0.38	0.20	3.80	15.91	458	3,610	3	68,729
Nondalton	Lake and Peninsula	0.59	0.28	4.75	11.34	394	162	3	22,658
Noorvik	Northwest Arctic	0.70	0.20	4.47	11.74	525	619	5	60,123
Northway	Southeast Fairbanks (CA)	0.49	0.18	2.25	13.66	320	84	3*	36,109*
Nuiqsut	North Slope	0.17	0.11	3.50	11.90	640	410	4	55,578
Nulato	Yukon-Koyukuk (CA)	0.63	0.19	3.93	13.72	348	249	4	29,057
Nunam Iqua	Wade Hampton (CA)	0.54	0.25	3.85	13.15	344	183	5	33,553
Nunapitchuk	Bethel (CA)	0.55	0.18	3.97		395	483	4	33,884
Old Harbor	Kodiak Island	0.61	0.19	3.77	13.33	304	219	3	37,603
Ouzinkie	Kodiak Island	0.40	0.21	3.33	14.06	318	169	3	60,743

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Pedro Bay	Lake and Peninsula	0.93	0.49	4.65	12.20	289	62	3	42,520
Pelican	Hoonah-Angoon (CA)	0.44	0.16	3.32	12.29	402	112	2	56,404
Perryville	Lake and Peninsula	0.58	0.43	3.00		300	130	3	60,020
Pilot Point	Lake and Peninsula	0.51	0.14	4.77	12.82	345	74	3	47,727
Pilot Station	Wade Hampton (CA)	0.63	0.19	3.80	12.66	423	544	5	35,950
Pitkas Point	Wade Hampton (CA)	0.62	0.18	3.50		297	92	4	48,450
Point Hope	North Slope	0.18	0.17	3.70	14.99	796	660	4	73,037
Point Lay	North Slope	0.16	0.15	3.55	13.24	683	196	4	79,545
Port Alsworth	Lake and Peninsula	0.66	0.19	4.16	11.80	335	129	3	67,975
Port Heiden	Lake and Peninsula	0.69	0.36	4.34		283	99	3	36,880
Quinhagak	Bethel (CA)	0.65	0.20	3.90	13.78	363	680	4	29,106
Red Devil	Bethel (CA)	1.01	0.26	5.25	8.12	235	33	3	12,655
Ruby	Yukon-Koyukuk (CA)	0.92	0.58	4.01	4.60	131	162	3	28,202
Russian Mission	Wade Hampton (CA)	0.63	0.20	3.90	13.87	480	314	4	31,818

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Saint Marys	Wade Hampton (CA)	0.62	0.18	3.50	14.02	349	548	4	45,557
Saint Michael	Nome (CA)	0.62	0.20	4.00	14.68	532	407	4	38,223
Saint Paul	Aleutians West (CA)	0.48	0.23	3.63	14.12	537	439	3	58,718
Sand Point	Aleutians East	0.49	0.21	3.29	13.99	457	1,051	3	64,118
Savoonga	Nome (CA)	0.59	0.20	3.93	14.20	469	660	4	27,118
Scammon Bay	Wade Hampton (CA)	0.63	0.19	3.90	13.48	439	474	5	29,648
Selawik	Northwest Arctic	0.66	0.19	4.47	13.54	475	825	4	29,648
Shageluk	Yukon-Koyukuk (CA)	0.75	0.20	4.00	11.32	252	91	4	30,854
Shaktoolik	Nome (CA)	0.61	0.19	3.93	13.81	517	245	4	36,880
Shishmaref	Nome (CA)	0.60	0.18	4.07	14.48	412	559	4	35,537
Shungnak	Northwest Arctic	0.71	0.20	4.47	13.51	533	260	5	51,343
Skagway	Skagway	0.21	0.15	1.93	14.39	467	881	3*	72,795*
Slana	Valdez-Cordova (CA)	0.53	0.19	2.36	12.86	281	141	3*	46,106*
Sleetmute	Bethel (CA)	1.01	0.26	5.25	10.54	245	77	3	17,355

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Stebbins	Nome (CA)	0.62	0.19	3.90	13.29	347	574	4	26,756
Stevens Village	Yukon-Koyukuk (CA)	1.10	0.63	5.20	10.99	102	86	3*	42,713*
Stony River	Bethel (CA)	1.01	0.26	5.30	9.64	145	47	2*	11,486*
Takotna	Yukon-Koyukuk (CA)	1.15	0.41	5.08	9.54	204	55	3	16,873
Tanana	Yukon-Koyukuk (CA)	0.74	0.26	3.38	13.42	227	242	3	34,421
Tatitlek	Valdez-Cordova (CA)	0.67	0.42	3.10	9.93	302	92	3	42,665
Teller	Nome (CA)	0.71	0.20	4.43	11.35	325	253	4	26,611
Tenakee Springs	Hoonah-Angoon (CA)	0.64	0.30	3.58	12.80	166	129	2	38,326
Tetlin	Southeast Fairbanks (CA)	0.33	0.17	2.11		334	126	4*	42,544*
Thorne Bay	Prince of Wales-Hyder (CA)	0.21	0.16	2.85	13.41	402	442	3	52,789
Togiak	Dillingham (CA)	0.61	0.18	3.90	13.16	410	808	4	27,742
Tok	Southeast Fairbanks (CA)	0.33	0.17	2.22	14.12	469	1,218	3*	55,122*
Toksook Bay	Bethel (CA)	0.55	0.18	4.03	14.45	446	601	5	34,951
Tuluksak	Bethel (CA)	0.61	0.24	4.38	13.20	244	365	5	36,519

Community Name	Census Region	Residential Rate 2010$ per kWh	Effective Rate 2010$ per kWh	Fuel Prices 2010$ per gallon	kWh per gallon	Average Residential Monthly Consumption	Population	Average Household Income, 2004 (2010$$)	Median Income (2004)* 2010$
Tuntutuliak	Bethel (CA)	0.65	0.26	3.60	13.50	357	380	4	29,504
Tununak	Bethel (CA)	0.55	0.18	4.03		388	318	4	28,925
Twin Hills	Dillingham (CA)	0.56	0.16	5.73	7.44	328	78	3	33,987
Unalakleet	Nome (CA)	0.48	0.19	3.61	13.48	444	685	3	48,691
Unalaska	Aleutians West (CA)	0.33	0.24	2.04	13.70	483	4,092	3	80,458
Wainwright	North Slope	0.17	0.15	4.40	12.43	644	536	4	63,314
Wales	Nome (CA)	0.67	0.19	4.07	12.56	362	153	3	38,567
Whale Pass	Prince of Wales-Hyder (CA)	0.47	0.21	2.14	12.34	208	37	2*	43,714*
White Mountain	Nome (CA)	0.92	0.50	3.01	9.57	296	209	3	29,889
Yakutat	Yakutat	0.46	0.24	3.10	13.38	446	742	3	54,132

Appendix G. Monthly Customer Payments under Current PCE Formula and Seasonal Fixed Payment Formula

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
Adak	Aleutians West	0.72	0.49	3.55	244	271	258	59	101	118	109	85%
Akiachak	Bethel	0.63	0.40	3.72	269	344	306	71	105	124	115	61%
Akiak	Bethel	0.63	0.32	4.55	219	256	238	75	129	152	140	87%
Akutan	Aleutians East	0.32	0.19	3.22	365	424	394	53	91	107	99	86%
Alakanuk	Wade Hampton	0.62	0.43	3.90	374	459	417	80	111	130	120	50%
Allakaket	Yukon-Koyukuk	0.70	0.51	4.38	204	270	237	45	124	146	135	201%
Ambler	Northwest Arctic	0.75	0.54	4.47	360	437	398	84	127	149	138	63%
Anaktuvuk Pass	North Slope	0.15	0.01	5.20	548	680	604	88	147	173	160	83%
Angoon	Hoonah-Angoon	0.47	0.27	2.78	391	433	412	81	79	93	86	6%
Aniak	Bethel	0.74	0.47	3.62	394	510	452	121	102	121	112	-8%
Anvik	Yukon-Koyukuk	0.67	0.49	4.17	317	337	327	61	118	139	128	110%
Atka	Aleutians West			4.19	394	395	395	93				39%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
		0.70	0.46						119	140	129	
Atmautluak	Bethel	0.77	0.41	3.59	319	362	340	124	102	120	111	-10%
Atqasuk	North Slope	0.19	0.02	3.00	723	844	783	140	85	100	93	-34%
Beaver	Yukon-Koyukuk	0.55	0.42	3.80	179	210	195	26	108	127	117	349%
Bethel	Bethel	0.50	0.34	5.05	444	566	505	80	143	168	156	95%
Bettles	Yukon-Koyukuk	0.61	0.42	2.65	319	446	382	72	75	88	82	13%
Brevig Mission	Nome	0.59	0.41	4.00	367	468	418	78	113	133	123	57%
Buckland	Northwest Arctic	0.52	0.29	5.00	464	582	523	127	142	167	154	22%
Central	Yukon-Koyukuk	0.60	0.29	2.27	156	179	167	51	64	76	70	36%
Chalkyitsik	Yukon-Koyukuk	0.95	0.37	4.18	112	134	123	71	118	139	129	81%
Chefornak	Bethel	0.63	0.37	4.13	398	450	424	111	117	138	127	15%
Chenega Bay	Valdez-Cordova	0.46	0.30	3.30	323	362	343	56	94	110	102	81%
Chevak	Wade Hampton	0.65	0.46	4.03	362	497	430	82	114	134	124	51%
Chignik	Lake and			2.75	333	238	286	51				66%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
	Peninsula	0.51	0.33						78	92	85	
Chignik Lagoon	Lake and Peninsula	0.44	0.29	3.93	456	401	428	65	111	131	121	87%
Chistochina	Valdez-Cordova	0.51	0.33	2.31	258	327	292	54	65	77	71	32%
Chitina	Valdez-Cordova	0.54	0.29	2.73	261	292	277	69	77	91	84	22%
Chuathbaluk	Bethel	0.99	0.74	5.15	175	259	217	55	146	172	159	187%
Circle	Yukon-Koyukuk	0.67	0.48	2.43	260	340	300	57	69	81	75	31%
Coffman Cove	Prince of Wales-Hyder	0.42	0.24	2.51	299	313	306	53	71	84	77	45%
Cold Bay	Aleutians East	0.62	0.44	3.65	384	427	405	70	103	122	113	60%
Cordova	Valdez-Cordova	0.33	0.10	2.23	498	536	517	124	63	74	69	-44%
Craig	Prince of Wales-Hyder	0.20	0.05	2.30	463	545	504	79	65	77	71	-10%
Crooked Creek	Bethel	0.99	0.74	5.25	261	304	282	72	149	175	162	125%
Deering	Northwest Arctic	0.77	0.43	4.71	326	447	381	130	133	157	145	12%
Dillingham	Dillingham	0.44	0.28	3.60	448	503	475	76	102	120	111	47%
Diomede	Nome			5.85	233	283	258	35				417%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
		0.60	0.47						166	195	180	
Eagle	Southeast Fairbanks	0.62	0.44	2.88	195	223	209	38	82	96	89	132%
Eek	Bethel	0.68	0.48	3.83	258	280	269	53	109	128	118	121%
Egegik	Lake and Peninsula	0.92	0.56	4.30	229	302	265	95	122	143	133	39%
Ekwok	Dillingham	0.50	0.37	3.70	360	315	338	46	105	123	114	150%
Elfin Cove	Hoonah-Angoon	0.56	0.38	4.42	233	131	182	31	125	147	136	333%
Elim	Nome	0.60	0.41	4.07	354	431	393	74	115	136	125	70%
Emmonak	Wade Hampton	0.63	0.43	3.90	398	486	442	87	111	130	120	39%
Fort Yukon	Yukon-Koyukuk	0.60	0.39	3.78	249	300	275	59	107	126	116	97%
Galena	Yukon-Koyukuk	0.56	0.34	4.30	312	430	365	82	122	143	133	62%
Gambell	Nome	0.61	0.42	3.93	316	425	370	69	111	131	121	75%
Golovin	Nome	0.70	0.51	5.10	284	354	319	61	145	170	157	159%
Goodnews Bay	Bethel	0.63	0.43	3.83	311	392	352	69	109	128	118	72%
Grayling	Yukon-Koyukuk			4.17	285	302	294	60				113%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
		0.70	0.49						118	139	128	
Gustavus	Hoonah-Angoon	0.57	0.30	2.71	166	152	159	44	77	90	84	92%
Haines	Haines	0.21	0.05	3.13	404	496	450	68	89	104	96	42%
Healy Lake	Southeast Fairbanks	0.64	0.41	2.53	220	318	269	64	72	84	78	22%
Holy Cross	Yukon-Koyukuk	0.67	0.48	4.10	297	346	322	61	116	137	126	106%
Hoonah	Hoonah-Angoon	0.47	0.27	2.40	404	444	424	84	68	80	74	-12%
Hooper Bay	Wade Hampton	0.61	0.43	4.00	301	375	338	63	113	133	123	94%
Hughes	Yukon-Koyukuk	0.71	0.38	4.45	262	321	291	98	126	148	137	41%
Huslia	Yukon-Koyukuk	0.63	0.43	4.13	373	433	403	79	117	138	127	61%
Igiugig	Lake and Peninsula	0.73	0.57	6.33	301	328	314	51	179	211	195	280%
Kake	Petersburg	0.47	0.27	2.71	359	390	374	74	77	90	84	13%
Kaktovik	North Slope	0.17	0.02	3.70	625	698	662	108	105	123	114	6%
Kalskag	Bethel	0.59	0.40	3.97	356	435	695	208	112	132	122	-41%
Kaltag	Yukon-Koyukuk			4.03	312	364	338	64				95%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
		0.63	0.44						114	134	124	
Karluk	Kodiak Island	0.60	0.47	3.58	416	523	470	63	102	119	110	74%
Kasigluk	Bethel	0.54	0.36	3.97	459	445	847	279	112	132	122	-56%
Kiana	Northwest Arctic	0.68	0.49	4.40	365	481	423	81	125	147	136	68%
King Cove	Aleutians East	0.25	0.10	2.36	380	470	425	64	67	79	73	14%
Kipnuk	Bethel	0.64	0.38	3.65	391	441	416	105	103	122	113	7%
Kivalina	Northwest Arctic	0.70	0.50	4.40	470	524	497	99	125	147	136	38%
Kokhanok	Lake and Peninsula	0.90	0.64	4.57	309	365	337	89	129	152	141	59%
Koliganek	Dillingham	0.50	0.37	5.06	266	280	273	37	143	169	156	323%
Kongiganak	Bethel	0.55	0.30	4.03	419	485	452	115	114	134	124	8%
Kotlik	Wade Hampton	0.59	0.40	3.67	384	526	455	85	104	122	113	33%
Kotzebue	Northwest Arctic	0.47	0.30	3.94	579	720	650	158	112	131	122	-23%
Koyuk	Nome	0.62	0.44	4.07	428	514	471	88	115	136	125	42%
Koyukuk	Yukon-Koyukuk			4.00	160	203	181	27				358%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
		0.45	0.30						113	133	123	
Kwethluk	Bethel	0.52	0.29	3.73	268	316	292	68	106	124	115	69%
Kwigillingok	Bethel	0.50	0.34	3.90	443	449	446	74	111	130	120	63%
Larsen Bay	Kodiak Island	0.40	0.19	3.59	311	292	301	64	102	120	111	74%
Levelock	Lake and Peninsula	0.70	0.57	8.50	164	208	190	25	241	283	262	959%
Lime Village	Bethel	1.25	0.59	8.20	78	86	82	54	232	273	253	372%
Manley Hot Springs	Yukon-Koyukuk	1.04	0.77	2.38	121	124	122	33	68	79	73	125%
Manokotak	Dillingham	0.50	0.32	3.88	313	355	334	62	110	129	120	94%
Marshall	Wade Hampton	0.63	0.44	3.57	385	480	433	83	101	119	110	32%
McGrath	Yukon-Koyukuk	0.60	0.44	3.82	334	392	363	61	108	127	118	94%
Mekoryuk	Bethel	0.65	0.46	3.70	245	294	270	51	105	123	114	124%
Mentasta Lake	Valdez-Cordova	0.52	0.33	2.33	252	297	274	51	66	78	72	40%
Minto	Yukon-Koyukuk	0.58	0.39	3.47	271	383	327	64	98	116	107	68%
Mountain	Wade Hampton			3.93	370	487	428	82				47%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
Village		0.60	0.41						111	131	121	
Naknek	Bristol Bay	0.44	0.27	3.50	393	401	397	65	99	117	108	66%
Napakiak	Bethel	0.96	0.72	4.37	268	347	307	75	124	146	135	80%
Napaskiak	Bethel	0.60	0.42	3.76	421	474	448	81	106	125	116	43%
Naukati Bay	Prince of Wales-Hyder	0.44	0.26	2.55	365	443	404	72	72	85	79	9%
Nelson Lagoon	Aleutians East	0.65	0.39	4.32	288	321	304	80	122	144	133	66%
New Stuyahok	Dillingham	0.62	0.43	4.13	406	453	430	81	117	138	127	57%
Newtok	Bethel	0.80	0.41	4.68	283	333	308	122	132	156	144	18%
Nikolai	Yukon-Koyukuk	0.80	0.39	4.83	335	382	359	147	137	161	149	2%
Nikolski	Aleutians West	0.60	0.39	4.50	329	346	338	72	128	150	139	93%
Noatak	Northwest Arctic	0.79	0.61	6.70	503	619	561	143	190	223	207	45%
Nome	Nome	0.37	0.18	3.80	415	501	458	89	108	127	117	32%
Nondalton	Lake and Peninsula	0.58	0.31	4.75	359	430	394	109	135	158	146	34%
Noorvik	Northwest Arctic			4.47	444	606	525	114				21%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
		0.69	0.50						127	149	138	
Northway	Southeast Fairbanks	0.48	0.31	2.25	261	380	320	57	64	75	69	22%
Nuiqsut	North Slope	0.17	0.05	3.50	533	748	640	80	99	117	108	35%
Nulato	Yukon-Koyukuk	0.62	0.43	3.93	326	371	348	66	111	131	121	84%
Nunam Iqua	Wade Hampton	0.53	0.29	3.85	301	388	344	84	109	128	119	41%
Old Harbor	Kodiak Island	0.60	0.41	3.77	271	337	304	58	107	126	116	100%
Ouzinkie	Kodiak Island	0.40	0.19	3.33	303	333	318	67	94	111	103	54%
Pedro Bay	Lake and Peninsula	0.91	0.43	4.65	270	308	289	140	132	155	143	2%
Pelican	Hoonah-Angoon	0.43	0.27	3.32	385	413	402	64	94	111	102	59%
Perryville	Lake and Peninsula	0.57	0.15	3.00	302	298	300	126	85	100	93	-27%
Pilot Point	Lake and Peninsula	0.50	0.37	4.77	321	394	345	46	135	159	147	220%
Pilot Station	Wade Hampton	0.62	0.43	3.80	346	500	423	81	108	127	117	45%
Point Hope	North Slope	0.18	0.02	3.70	749	842	796	135	105	123	114	-16%
Point Lay	North Slope			3.55	616	749	683	101				8%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
		0.16	0.02						101	118	109	
Port Alsworth	Lake and Peninsula	0.65	0.47	4.16	321	348	335	62	118	139	128	106%
Port Heiden	Lake and Peninsula	0.68	0.32	4.34	283	284	283	102	123	145	134	31%
Quinhagak	Bethel	0.64	0.44	3.90	326	399	363	72	111	130	120	67%
Red Devil	Bethel	0.99	0.74	5.25	219	250	235	60	149	175	162	171%
Ruby	Yukon-Koyukuk	0.91	0.34	4.01	118	145	131	75	114	134	124	65%
Russian Mission	Wade Hampton	0.62	0.42	3.90	422	538	480	94	111	130	120	28%
Saint Marys	Wade Hampton	0.61	0.43	3.50	309	388	646	178	99	117	108	-39%
Saint Michael	Nome	0.61	0.41	4.00	435	630	532	116	113	133	123	6%
Saint Paul	Aleutians West	0.47	0.24	3.63	520	554	537	130	103	121	112	-14%
Sand Point	Aleutians East	0.48	0.28	3.29	426	488	457	93	93	110	101	9%
Savoonga	Nome	0.58	0.39	3.93	411	526	469	91	111	131	121	33%
Scammon Bay	Wade Hampton	0.62	0.43	3.90	398	480	439	82	111	130	120	47%
Selawik	Northwest Arctic			4.47	392	557	475	89				54%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
		0.65	0.46						127	149	138	
Shageluk	Yukon-Koyukuk	0.74	0.54	4.00	230	273	252	50	113	133	123	145%
Shaktoolik	Nome	0.60	0.42	3.93	481	553	517	104	111	131	121	17%
Shishmaref	Nome	0.59	0.42	4.07	364	461	412	72	115	136	125	75%
Shungnak	Northwest Arctic	0.79	0.54	4.47	475	591	955	483	127	149	138	-71%
Skagway	Skagway	0.21	0.05	1.93	437	497	467	70	55	64	59	-16%
Slana	Valdez-Cordova	0.52	0.34	2.36	241	322	281	52	67	79	73	39%
Sleetmute	Bethel	0.99	0.74	5.25	227	264	245	63	149	175	162	159%
Stebbins	Nome	0.61	0.42	3.90	304	390	347	64	111	130	120	87%
Stevens Village	Yukon-Koyukuk	1.07	0.46	5.20	0	102	102	62	147	173	160	157%
Stony River	Bethel	0.99	0.74	5.30	133	158	145	37	150	177	163	341%
Takotna	Yukon-Koyukuk	1.14	0.74	5.08	198	210	204	82	144	169	156	92%
Tanana	Yukon-Koyukuk	0.73	0.48	3.38	200	254	227	57	96	113	104	82%
Tatitlek	Valdez-Cordova			3.10	271	332	302	123				-22%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
		0.66	0.25						88	103	96	
Teller	Nome	0.70	0.50	4.43	292	358	325	65	126	148	137	111%
Tenakee Springs	Hoonah-Angoon	0.63	0.34	3.58	170	163	166	49	101	119	110	127%
Togiak	Dillingham	0.60	0.42	3.90	374	445	410	74	111	130	120	61%
Tok	Southeast Fairbanks	0.32	0.16	2.22	413	525	469	77	63	74	68	-11%
Toksook Bay	Bethel	0.54	0.36	4.03	421	471	1,281	513	114	134	124	-76%
Tuluksak	Bethel	0.60	0.37	4.38	221	267	244	57	124	146	135	135%
Tuntutuliak	Bethel	0.64	0.39	3.60	344	370	357	91	102	120	111	22%
Twin Hills	Dillingham	0.55	0.39	5.73	292	363	328	52	162	191	177	241%
Unalakleet	Nome	0.47	0.29	3.61	411	477	444	81	102	120	111	37%
Unalaska	Aleutians West	0.33	0.09	2.04	448	517	483	116	58	68	63	-46%
Wainwright	North Slope	0.17	0.02	4.40	610	677	644	100	125	147	136	35%
Wales	Nome	0.66	0.47	4.07	328	395	362	68	115	136	125	86%
Whale Pass	Prince of Wales-			2.14	214	201	208	43				55%

Community name	Census region	Residential rate, $/kWh	PCE level, kWh	Fuel price, $/gallon	Average summer consumption per customer, kWh/month	Average winter consumption per customer, kWh/month	Average annual consumption per customer, kWh/month	PCE payment under current PCE formula, $/Month	PCE summer payment under Seasonal Fixed Payment formula, $/Month	PCE winter payment under Seasonal Fixed Payment formula, $/Month	Average annual payment under Seasonal Fixed Payment formula, $/Month	Net annual change
	Hyder	0.47	0.26						61	71	66	
White Mountain	Nome	0.90	0.41	3.01	268	324	296	144	85	100	93	-36%
Yakutat	Yakutat	0.45	0.21	3.10	447	446	446	105	88	103	96	-9%

Appendix H. Data sources and methods

Power Cost Equalization program data

Information for this analysis was obtained primarily from existing reports and datasets. AEA has been collecting and publishing PCE program data since 1988. In 1988, the first Annual PCE Statistical report was published containing data from 1981 to 1988 (including PCA and PCCA). The Annual PCE Statistical reports are still available. For the years 1981 to 2000, PCE data is only available at the annual level. Annual reports contain data at the utility and annual level regarding kWh generated and sold, fuel prices, residential and PCE levels and effective rates and other useful information. Data from these printed reports was manually entered into an Excel dataset by ISER researchers. Currently, AEA uses a software tool called NAVISION to store program data. Information collected from Utility PCE Monthly reports is stored in the database in addition to disbursements and financial data; this information is used to publish the Annual PCE Statistical reports. Since 2001, PCE data is available on a monthly basis from the NAVISION database.

Other sources

Information regarding community characteristics such as income and average household size are from the U.S. Census American Community Survey estimates; other characteristics such as population and unemployment rate are from the U.S. Census Bureau and Alaska Department of Labor and Workforce Development. ISER recently completed *Alaska Electric Energy Statistics* reports which were also used as reference. In addition, in 2008, the McDowell Group prepared the Alaska Geographic Differential Study for the Alaska Department of Administration providing an analysis of cost of living differences in various regions of the state.

Finally, a literature review was performed including previous reports and analyses regarding changes to policy and program guidelines, readings regarding subsidies and economic theory and a number of statistical, econometric and technical resources were used.[33]

Data quality

We assumed that PCE program data from PCE Annual Statistical reports were reviewed to at least a minimum level of statistical validity. However, because utilities may not participate in the program all year or because of failure to submit all monthly reports, data presented as annual data for that utility may actually be data for less than a full year. In addition, within that partial year of data, some variable may have even fewer months of reported data. These issues of inconsistent reporting and lack of documentation of missing data severely hinder the ability to conduct time series analysis. For analyses in which a complete data set was critical, we did an earnest effort to control for the number of months for each observation or using only cases with complete sets of data for calculations. Data from these complete sets were used when analyzing the program over time.

[33] A complete list of sources is listed in the "References" section.

Variables such as residential and PCE electric rates, disbursements, number of customers and kilowatt-hours sold are of higher quality than other variables in the database. This information is reviewed by AEA staff against documentation submitted by the utility. Variables such as fuel and non-fuels costs, generation and others are not reviewed to the same level of scrutiny because they are not relevant to providing the disbursement to the utility and because that information is more carefully reviewed by the RCA. Because these agencies operate independently and no formal mechanisms exist to reconcile data submitted by the utilities to both agencies, data discrepancies are unfortunately common. PCE program data from AEA is more readily available and accessible than data from RCA. However, PDF copies of the Annual Re-calculation of PCE Level were provided by RCA staff. Data regarding fuel and non-fuel cost were used from this reports when possible.

The U.S. Census American Community Survey (ACS) strives to produce high quality data, however because of the challenges of collecting data for Alaska given a relatively small population and sample sizes, it is not uncommon for ACS data to have large margin of errors. The ACS five year average data were used in an effort to use the most accurate estimates.

Information from the *Alaska Geographic Differential Study* was of limited use because sample sizes were small and often did not match the communities considered in this report.

Methods

Data from all sources was digitally input into Microsoft Excel workbooks and/or STATA (statistical software) datasets. In addition, to the quality measures taken by all sources, all data sets were reviewed for consistency and accuracy. When data from different sources was merged, the match was done at the community level using the community identification number.

Data calculations were done using both Excel and STATA. However, all analytical models were done using Excel because of its flexibility and potential ease of distribution to all interested readers and reviewers. A sensitivity analysis was done for all PCE formula models reviewed in this report for which worksheet models were created.

Time series data from PCE Annual Reports is only available per fiscal year; hence it was presented in this way in the report. However, other data sources present data based on a calendar year so PCE Navision monthly data was aggregated to a calendar year level to allow proper analysis.

Analysis regarding the program in its current form or for reviewing potential funding formula alternative was based on current monthly PCE data from the NAVISION system. For descriptions of the program history and changes over time, annual data were used.

Appendix I. Map of Alaska Energy Regions